TRIOBASIC COMMANDS 2

Contents

Introduction to TrioBASIC

TrioBASIC is multi-tasking programming language used by the Trio multitasking *Motion Coordinator* range of programmable motion controllers. The syntax is similar to that of other **`BASIC`** family languages. A PC running the Microsoft Windows™ operating system is used to develop and test the application programs which coordinate all the required motion and machine functions using Trio's *Motion* Perfect software. *Motion* Perfect provides all editing and debugging functionality needed to write and debug applications written in TrioBASIC. The completed application does not require the PC in order to run.

FEATURES

- Fast BASIC language for easy standalone machine programming
- Fully integrated with Trio's *Motion* Perfect application development software
- Comprehensive motion control functions for multiple axes
- Multi-tasking of multiple programs for improved software structure and maintenance
- Support for traditional servo or stepper axes as well as modern digital (**`SERCOS`**, EtherCAT etc) axes
- A comprehensive set of move types supporting multiple axis coordination as well as simple single axis moves. This includes linear, circular, and spherical interpolation as well as cam profiles and software gearboxes
- Real maths (up to 64 bit) including bit operators and variables
- Support for hardware position capture
- Support for high speed outputs

TrioBASIC has over 300 commands designed to make programming motion functions quick and simple.

How to use this this manual

The TrioBASIC programming reference guide lists all the TrioBASIC keywords used in the MC4xx range of *Motion Coordinator*s in alphabetical order. A TrioBASIC keyword can be a simple parameter, or a command with a clearly defined function, such as **`FORWARD`** or **`HALT`**, whereas others may take one or more parameters which affect the operation of the command.

This short introduction is intended to provide a guide to using the main programming reference. It identifies the concepts and some words and phrases which have a particular meaning within the context of this manual.

COMMAND REFERENCE ENTRY

Each TrioBASIC keyword is described in the technical reference manual using a standard format. The keyword name is given, what type of TrioBASIC keyword it is, an example of syntax and then a description of its parameters and overall operation. Finally an example of it in a typical program is given when available.

Here is the typical layout.

KEYWORD_NAME

Type:
The keyword type; e.g. **`SYSTEM PARAMETER`**

Syntax:
The definition of the keyword syntax. Where parameters are optional, they are enclosed in square brackets [].

Description:
A brief description of command or parameter, informing what it does and how it may interact with other parameters or commands.

Parameters:
A table of all the parameters for the command. If the keyword is a parameter itself, then this section will be missed.

Examples:
Example 1:
Where available, at least one example will be shown. When the command is a motion command, the example may be a small sub-set of the sequence needed to show the command working in a realistic application.

See also:
A list of other related keywords so that the reader can easily cross-reference.

KEYWORD TYPES

Keywords are split into groups according to their function, where they may be used and where they are stored in the *Motion Coordinator*. A keyword may have more than one type. For example, a keyword can be a System Variable and be available for use in the **`MC_CONFIG`** initialisation program.

Below is a table describing all the keyword types.

Axis command	A command sent to a particular axis. An axis command will usually have one or more parameters in parentheses. It will operate on the **`BASE`** axis that is set, but it can also take the **`AXIS`** modifier keyword. e.g. **`MOVE(100),  REGIST(21, 4, 0, 1, 0) AXIS(15)`**
Axis Parameter	A parameter which is associated with a particular axis. An axis parameter will operate on the **`BASE`** axis that is set, but it can also take the **`AXIS`** modifier keyword. e.g. **`P_GAIN = 1.2,  x = MPOS AXIS(2)`**
Command line only	The command or parameter may be entered in the command line on *Motion* Perfect terminal 0. It may NOT be used within an executable TrioBASIC program.
Constant	The keyword returns a constant value. Used to make common program constants more readable. e.g. **`OP(10, ON), WAIT UNTIL MARK = TRUE`**

FLASH	The parameter is automatically stored in the flash memory and will therefore be available on the next and all subsequent power ups. Note that parameters stored to Flash from the command line are not referenced in the *Motion* Perfect project and must be documented separately. For this reason, the use of **`MC_CONFIG`** is recommended even if the parameter is also stored in the Flash.
Mathematical function	The keyword is a typical TrioBASIC mathematical function which can take one or more operands and which returns a result. e.g. **`x = COS(y),  value = ATAN2(VR(10), VR(11))`**
MC_CONFIG	The parameter is available for use in the **`MC_CONFIG`** script which runs automatically on power up while configuring the system.
Modifier	A modifier keyword is used to modify the target axis, process, port or slot that a command is sent to, or that a parameter is sent to or read from. e.g. **`CONNECT(1,3) AXIS(10),  x = PROC_STATUS PROC(21), PRINT FPGA_VERSION SLOT(2)`**
Process parameter	A parameter which gives the status of a process in the multi-tasking, or which, if written to, has some control function in the multi-tasking. A process parameter operates on process 0 unless the **`PROC`** modifier is used.
Program Structure	
Slot Parameter	A slot parameter gives some information about the status of the hardware on that slot. Some slot parameters also have a control function when written to. A slot parameter operates on slot 0 unless the **`SLOT`** modifier is used. e.g. **`VR(10) = SERCOS_PHASE SLOT(2), PRINT FPGA_VERSION SLOT(-1)`**
System command	A command which operates on the system firmware, or on a part of the *Motion Coordinator* hardware. A system command may have one or more parameters contained within parentheses. **`e.g. AUTORUN,  SETCOM(19200,8,1,2,2,4)`**
System parameter	A parameter which is associated with the system as a whole. A system parameter may control or give the status of something in the operating firmware, or it may be hardware specific. e.g. **`NIO, TIME$`**

All functions and commands will accept an expression as well as a single variable. For example; a valid expression might be **`MOVE(COS(x)*VR(1)/100)`**.

KEYWORD SYNTAX

Each entry in the TrioBASIC reference manual shows the syntax of the keyword in a standard form. Syntax, the way you use the keyword, appears in 3 formats in TrioBASIC.

COMMAND

Commands come in 3 types; those which take parameters and those which do not. An example of a command with parameters is shown here.

```
MHELICAL(end1, end2, centre1, centre2, direction, distance3 [,mode])
```

Parameters are contained within parentheses. (round brackets) If there is more than one parameter, then they are separated by a comma. Optional parameters are shown in the syntax description within square brackets. The square brackets are not used when writing the command in a program, so if the optional parameter is used, just insert the comma and the value or expression without square brackets.

Commands which do not have parameters are just entered as the keyword with no parentheses or brackets. For example; **`FORWARD`**

FUNCTION

Functions can both take a value, or values, and will also return a value. The values given to the function are in parentheses, in the same way as for a command. One or more values may be passed to the function. Mathematical functions are typical of this syntax type;

```
value = COS(expression)
value = ABS(expression)
```

PARAMETER

A parameter carries a value and therefore works in the same way as a variable. A value can be assigned to a parameter or a value can be read from a parameter. Some parameters are read only. This will be shown in the keyword type information.

Some examples of parameter syntax are;

```
P_GAIN = 1.0
VR(10) = PROC_STATUS PROC(3)
IF MPOS AXIS(10) > (ENDMOVE AXIS(10) - 200) THEN
CANIO_ADDRESS = 40
```

CONSTANT

Some keywords are provided to make common constants available to the programmer. These are, of course, read-only. Constants, for the purpose of syntax, can be thought of as a sub-set of the parameter type. Some examples are;

```
    circumference = PI * diameter
    IF result = FALSE THEN
    WHILE TRUE
    OP(30,OFF)
    bit3 = ON
```

VARIABLES

Variables that may be used in expressions or as parameters within a command or function can be stored in volatile RAM, in non-volatile battery backed RAM or in non-volatile Flash memory. A variable may also be local or global.

Local variable	A local variable is given a user defined name. The name can contain letters, numbers and the underscore "_" character. It can be of any length, but only the first 32 characters are used to identify the unique variable name. The value of a local variable is known only to the process that it was defined in. Local variables are volatile and will be lost at power down. e.g. `elapsed_time = -TICKS/1000`
Global variables	Global variables, otherwise known as **VR** variables, are held in non-volatile memory. In the MC464 this is maintained by a lithium battery. In the MC403/MC405, the global variables are stored in the Flash memory. Global variables can be accessed from all processes including the command line in terminal 0. There are a fixed number of global variables. Each variable is accessed by index number, e.g. `value=VR(123)`. See the relevant hardware manual for the highest index number. e.g. `batch_size = VR(101)`
TABLE values	Another range of globally accessible values is the **TABLE** memory. This is a large indexed array of variables which has a special purpose in some commands. It can also be used as a general memory for application programs. Table memory may be either volatile or non-volatile. See the appropriate hardware manual for details. e.g. `TABLE(100, 1.2, 2.3, 4.5, 6.8, 9.0, 15.4, 23.7)`

VARIABLE SYNTAX

The default data type of all variables is double precision float. However, the floating point data type can also store integers up to 52 bits plus sign. Therefore all variables and most parameters can be referenced as if they are integers, without any need to create a separate integer data type definition.

```
    my_variable = 450.023 ‘ decimal float
    my_variable = 450 ‘ decimal integer
    my_variable = $FF6A ‘ hexadecimal integer
    my_variable.5 = 1 ‘ sets bit 5 to 1
```

Versions of firmware released after the middle of 2012 have more advanced data types available. For example the String type can be defined by the use of the DIM statement. See under DIM in the Trio **BASIC** reference manual for further information.

LABELS

A label is a place marker in the program. Labels are given user defined names. The name can contain letters, numbers and the underscore "_" character. It can be of any length, but only the first 32 characters are used to identify the unique variable name. The label position is defined by putting the colon ":" character after the label name. The line containing the label can then be referenced within a **GOTO** or **GOSUB** command.

```
start_of_program:

  raduis1 = 123
  GOSUB calc_circle_radius
  PRINT #5,area1
  WA(500)
GOTO start_of_program

calc_circle_area:
  area1 = PI * radius1 ^ 2
RETURN
```

EXAMPLES

Each keyword entry shows one or more example of how to use the keyword in a realistic context. Sophisticated commands, like the main motion commands, will show a reasonably complete example with all the other associated commands which are required to make the core of a typical application.

More complete programming solutions can be found in Trio's wide range of application notes and programming guides.

ABS

TYPE:
Mathematical function

SYNTAX:
`value = ABS(expression)`

DESCRIPTION:
The ABS function converts a negative number into its positive equal. Positive numbers are unaltered.

PARAMETERS:

Expression:	Any valid TrioBASIC expression

EXAMPLE:
Check to see if the value from analogue input is outside of the range -100 to 100.

```
IF ABS(AIN(0))>100 THEN
  PRINT "Analogue Input Outside +/-100"
ENDIF
```

ACC

TYPE:
Axis command

SYNTAX:
`ACC(rate)`

DESCRIPTION:
Sets both the acceleration and deceleration rate simultaneously.

This command is provided to aid compatibility with older Trio controllers. Use the AC**CEL** and **DECEL** axis parameters in new programs.

PARAMETERS:

rate:	The acceleration rate in **UNITS**/SEC/SEC.

EXAMPLES:

EXAMPLE 1:

Move an axis at a given speed and using the same rates for both acceleration and deceleration.

```
ACC(120)     'set accel and decel to 120 units/sec/sec
SPEED=14.5   'set programmed speed to 14.5 units/sec
MOVE(200)    'start a relative move with distance of 200
```

EXAMPLE 2:

Changing the ACC whilst motion is in progress.

```
SPEED=100000          'set required target speed (units/sec)
ACC(1000)                 'set initial acc rate
FORWARD
WAIT UNTIL VP_SPEED>5000  'wait for actual speed to exceed 5000
ACC(100000)               'change to high acc rate
WAIT UNTIL SPEED=VP_SPEED 'wait until final speed is reached
WAIT UNTIL IN(2)=OFF
CANCEL
```

ACCEL

TYPE:

Axis parameter

DESCRIPTION:

The **ACCEL** axis parameter may be used to set or read back the acceleration rate of each axis fitted. The acceleration rate is in **UNITS**/sec/sec.

EXAMPLE:

Set the acceleration rate and print it to the terminal

```
ACCEL=130
PRINT " Acceleration rate= ";ACCEL;"mm/sec/sec"
```

ACOS

TYPE:

Mathematical Function

SYNTAX:

```
ACOS(expression)
```

DESCRIPTION:

The **ACOS** function returns the arc-cosine of a number which should be in the range 1 to -1. The result in radians is in the range 0..PI

Parameters:

Expression:	Any valid TrioBASIC expression returning a value between -1 and 1.

EXAMPLE:

Print the arc-cosine of -1 on the command line

```
>>PRINT ACOS(-1)
3.1416
>>
```

+ Add

TYPE:

Mathematical operator

SYNTAX:

```
<expression1> + <expression2>
```

DESCRIPTION:

Adds two expressions

PARAMETERS:

Expression1:	Any valid TrioBASIC expression
Expression2:	Any valid TrioBASIC expression

EXAMPLE:

Add 10 onto the expression in the parentheses and store in a local variable. Therefore ‘result’ holds the value 28.9

```
result=10+(2.1*9)
```

ADD_DAC

TYPE:
Axis Command

SYNTAX:
`ADD_DAC(axis)`

DESCRIPTION:
Adds the output from the servo control block of a secondary axis to the output of the base axis. The resulting **DAC_OUT** of the base axis is then the sum of the two control loop outputs.

The **ADD_DAC** command is provided to allow a secondary encoder to be used on a servo axis to implement dual feedback control.

This would typically be used in applications such as a roll-feed where a secondary encoder to compensate for slippage is required.

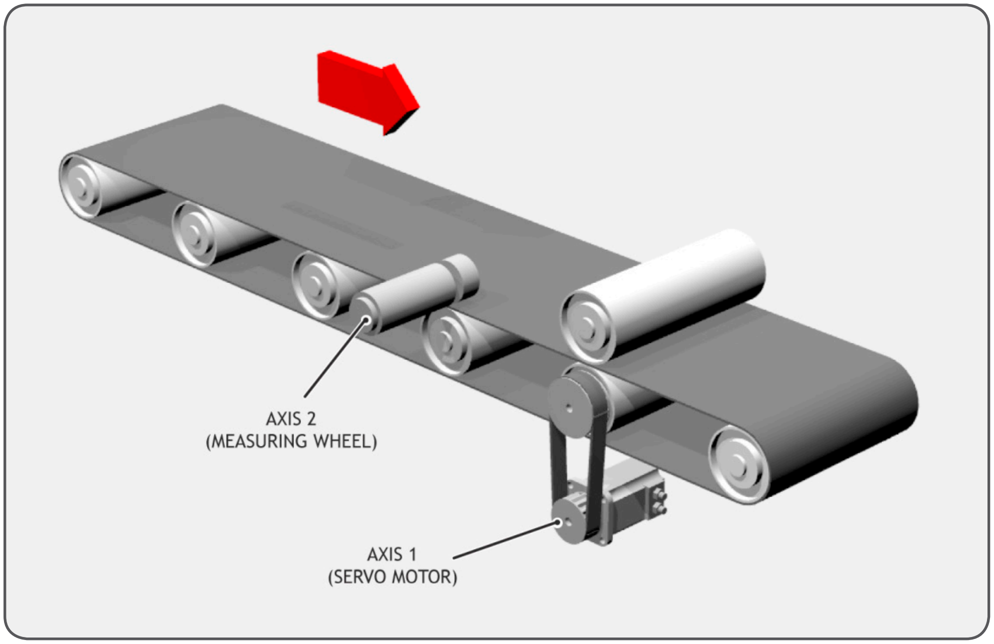
PARAMETERS:

axis:	Number of the second axis, who's output will be added to the base axis. -1 will terminate the **ADD_DAC** link.

EXAMPLE:
Use **ADD_DAC** to add the output of a measuring wheel to the servo motor axis controlling a roll-feed. Set up the servo motor axis as usual with encoder feedback from the motor drive. The measuring wheel axis must also be set up as a servo. This is so that the software will perform the servo control calculations on that axis.

It is necessary for the two axes to be controlled by a common demand position. Typically this would be achieved by using **ADDAX** to produce a matching **DPOS** on **BOTH** axes. The servo gains are then set up on **BOTH** axes, and the output summed on to one physical output using **ADD_DAC**.

If the required demand positions on both axes are not identical due to a difference in resolution between the 2 feedback devices, **ENCODER_RATIO** can be used on one axis to produce matching **UNITS**.



```
BASE(1)
ATYPE = 44
' No need to scale the servo encoder as it is the highest resolution
ENCODER_RATIO(1,1)

' Link to the output of the encoders virtual DAC
ADD_DAC(2)
UNITS = 10000

' Disable the output from the servo control block by setting PGAIN = 0
P_GAIN = 0
SERVO = ON

BASE(2)
' ATYPE must be set to a servo ATYPE to enable the closed position loop
ATYPE = 44

' Set the encoder ratio so that it has the same counts per rev as the
servo
ENCODER_RATIO(10000,4096)
```

```
` Superimpose axis 1 demand on axis 2
ADDAX(1)
UNITS = 10000

` Use servo control block from encoder axis by setting >0 P_GAIN
P_GAIN = 0.5
SERVO = ON

WDOG=ON

BASE(1)
` Start movements
MOVE(1200)
WAIT IDLE
```

ADDAX

TYPE:
Axis command

SYNTAX:
`ADDAX(axis)`

DESCRIPTION:
The **ADDAX** command is used to superimpose 2 or more movements to build up a more complex movement profile:

The **ADDAX** command takes the demand position changes from the specified axis and adds them to any movements running on the base axis.

After the **ADDAX** command has been issued the link between the two axes remains until broken and any further moves on the specified axis will be added to the base axis.

The specified axis can be any axis and does not have to physically exist in the system

The **ADDAX** command therefore allows an axis to perform the moves specified on TWO axes added together.

When using an encoder with **SERVO=OFF** the **MPOS** is copied into the **DPOS**. This allows **ADDAX** to be used to sum encoder inputs.

PARAMETER:

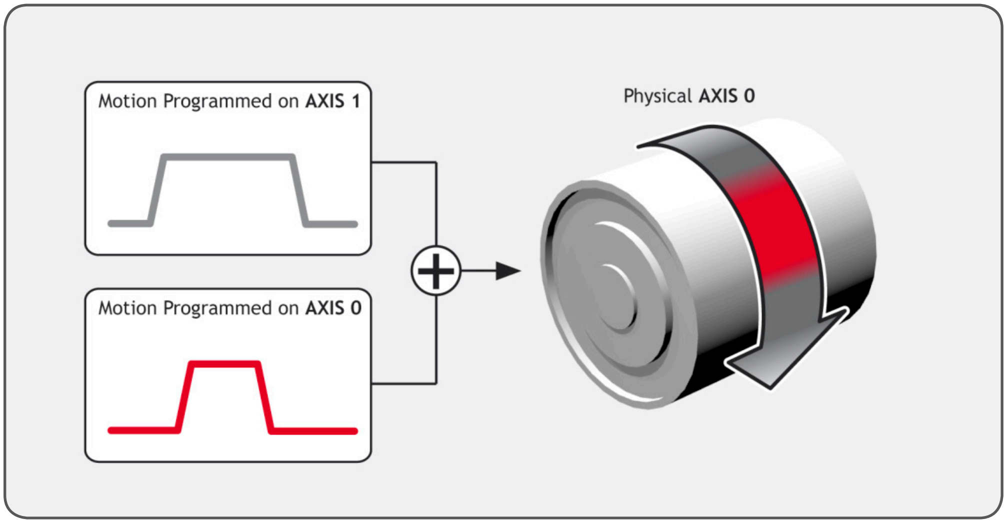
axis:	Axis to superimpose. -1 breaks the link with the other axis.

The **ADDAX** command sums the movements in encoder edge units.

EXAMPLES:

EXAMPLE 1:

Using **ADDAX** on axis with different **UNITS**, Axis 0 will move 1*1000+2*20=1040 edges.



```
UNITS AXIS(0)=1000
UNITS AXIS(1)=20
'Superimpose axis 1 on axis 0
ADDAX(1) AXIS(0)
MOVE(1) AXIS(0)
MOVE(2) AXIS(1)
```

EXAMPLE 2:

Pieces are placed randomly onto a continuously moving belt and further along the line are transferred to a second flighted belt. A detection system gives an indication as to whether a piece is in front of or behind its nominal position, and how far.

ADDAX_AXIS

TYPE:
Axis Parameter (Read Only)

DESCRIPTION:
Returns the axis currently linked to with the **ADDAX** command, if none the parameter returns -1.

EXAMPLE:
Check if an **ADDAX** to axis 2 exists as part of a reset sequence, if it does then cancel it.

```
IF ADDAX_AXIS = 2 then
  ADDAX(-1)
ENDIF
```

ADDRESS

TYPE:
System Parameter

DESCRIPTION:
Sets the RS485 or Modbus multi-drop address for the controller.

VALUE:
Node address, should be in the range of 1..32. If it is set to 255 addressing is not used and all 8 characters from the packet are sent through to the user.

EXAMPLE:
Initialise Modbus as node 5

```
ADDRESS=5
SETCOM(19200,8,1,2,1,4)
```

AFF_GAIN

TYPE:
Axis Parameter

DESCRIPTION:
Sets the acceleration Feed Forward for the axis. This is a multiplying factor which is applied to the rate of change of demand speed. The result is summed to the control loop output to give the **`DAC_OUT`** value.

`AFF_GAIN` is only effective in systems with very high counts per revolution in the feedback. I.e. 65536 counts per rev or greater.

AIN

TYPE:
System Command

SYNTAX:
`AIN(channel)`

DESCRIPTION:
Reads a value from an analogue input. Analogue inputs are either built in to the *Motion Coordinator* or available from the CAN Analogue modules.

The value returned is the decimal equivalent of the binary number read from the A to D converter.

The built in analogue inputs are updated every servo period.

The CAN analogue inputs are updated every 10msec

PARAMETERS:

channel:	Analogue input channel number 0...35	
	0 to 31	CAN analogue input channel number
	32 to 35	Built in analogue input channel number

If no CAN Analog modules are fitted, **`AIN`**(0) and **`AIN`**(1) will read the first two built-in channels so as to maintain compatibility with previous versions.

EXAMPLE:
Material is to be fed off a roll at a constant speed. There is an ultrasonic height sensor that returns 4V when the roll is empty and 0V when the roll is full. A lazy loop is written in the **`BASIC`** to control the speed of the roll.

```
    MOVE(-5000)
    REPEAT
      a=AIN(1)
      IF a<0 THEN a=0
      SPEED=a*0.25
    UNTIL MTYPE=0
```

The analogue input value is checked to ensure it is above zero even though it always should be positive. This is to allow for any noise on the incoming signal which could make the value negative and cause an error because a negative speed is not valid for any move type except **FORWARD** or **REVERSE**.

AIN0..3 / AINBI0..3

TYPE:
System Parameter

DESCRIPTION:
These system parameters duplicate the AIN() command.

AIN0..3 is used for single sided analogue inputs.

AINBI0..3 is used for bipolar inputs.

They provide the value of the analogue input channels in system parameter format to allow the **SCOPE** function (Which can only store parameters) to read the analogue inputs.

If no CAN Analogue modules are fitted, AIN0 and AIN1 will read the first two built-in channels.

AND

TYPE:
Logical and Bitwise operator

SYNTAX:
`<expression1> AND <expression2>`

DESCRIPTION:
This performs an AND function between corresponding bits of the integer part of two valid TrioBASIC expressions.

The AND function between two bits is defined as follows:

AND	0	1

0	0	0
1	0	1

PARAMETERS:

expression1:	Any valid TrioBASIC expression
expression2:	Any valid TrioBASIC expression

EXAMPLES:

EXAMPLE 1:
Using AND to compare two logical expressions, if they are both true then set a local variable.

```
    IF (IN(6)=ON) AND (DPOS>100) THEN
      tap=ON
    ENDIF
```

EXAMPLE 2:
Use AND as a bitwise operator.

```
    VR(0)=10 AND (2.1*9)
```

ANYBUS

TYPE:
System Function

SYNTAX:
`ANYBUS(function, slot [, parameters…])`

DESCRIPTION:
This function allows the user to configure the active Anybus module and set the network to an operation state. Some networks have limitations on data types and size, please refer the Anybus data sheet for details.

Passive modules require no setup and will appear as a communication channel, they can then be used with `PRINT`, `GET` etc. These modules can be configured using the `SETCOM` command.

PARAMETERS:

function:	0	Configure map
	1	Configure module and start protocol
	2	Stop protocol
	3	Read status byte
	4	Auto configure mapping

FUNCTION = 0:

SYNTAX:

`value = ANYBUS(0,slot [, map, source [, index, type, count, direction [,endian]]])`

DESCRIPTION:

Assigns a **`VR`** or table point to the memory area that is updated over the network. Individual or all maps can be deleted using the first 4 parameters.

The current mapping can be printed to the terminal using the first 2 parameters.

PARAMETERS:

value:	**TRUE** = the command was successful	
	FALSE = the command was unsuccessful	
slot:	Module slot in which the Anybus is fitted	
map:	Map number, use -1 to delete all maps	
source:	Location for data on the MC464	
	-1	delete map
	0	VR
	1	Table
index:	Start position in data source	

type:	The size and type of data that is sent across the bus	
	0	boolean
	1	signed 8 bit integer
	2	signed 16 bit integer
	3	signed 32 bit integer
	4	unsigned 8 bit integer
	5	unsigned 16 bit integer
	6	unsigned 32 bit integer
	7	character
	8	enumeration
	9-15	(reserved)
	16	signed 64 bit integer
	17	unsigned 64 bit integer
	18	floating point/real number
count:	Number of data types mapped	
direction:	Data direction	
	0	data read into the controller
	1	data transmitted from the controller
endian	0	Use default endian from network (default)
	1	Swap endian

FUNCTION = 1:

SYNTAX:

```
value = ANYBUS(1,slot [, address, baud])
```

DESCRIPTION:

Resets the Anybus module, loads the mapping and then sets the network to operational mode using the parameters provided.

PARAMETERS:

value:	**`TRUE`**	the command was successful
	`FALSE`	the command was unsuccessful
slot:	Module slot in which the Anybus is fitted	
address:	Module address, node number, MAC id. etc *(not required for Profinet)*	
baud:	Baud rate CC Link - required	
	0	156 kbps
	1	625 kbps
	2	2.5 Mbps
	3	5 Mbps
	4	10 Mbps
	Baud rate Devicenet – optional	
	0	125 kbps
	1	250 kbps
	2	500 kbps
	3	autobaud (default)
	Baud rate Profibus – automatic, not required	

FUNCTION = 2:

SYNTAX:
`value = ANYBUS(2,slot)`

DESCRIPTION:
Stops the cyclic data transfer.

PARAMETERS:

value:	**`TRUE`**	the command was successful
	`FALSE`	the command was unsuccessful
slot:	Module slot in which the Anybus is fitted	

FUNCTION = 3:

SYNTAX:
value = **ANYBUS**(3,slot)

DESCRIPTION:
Reads the status byte from the Anybus module.

PARAMETERS:

value:	Anybus status byte:		
	Bits 0-2:	Anybus State:	
		0	**SETUP**
		1	**NW_INIT**
		2	**WAIT_PROCESS**
		3	**IDLE**
		4	**PROCESS_ACTIVE**
		5	**ERROR**
		6	(reserved)
		7	**EXCEPTION**
	Bit 3	Supervisory bit:	
		0	Module is not supervised
		1	Module is supervised by another network device
	Bits 4-7	(reserved)	
slot:	Module slot in which the Anybus is fitted		

FUNCTION = 4:

SYNTAX:
value = ANYBUS(4,slot [, address], type, inoff, outoff [,endian])

DESCRIPTION:
Auto-configure and start the cyclic network. The mapping can still be read using function 0.

This function only works with Profibus and Profinet. Profinet does not require the address parameter.

PARAMETERS:

value:	**TRUE**	the command was successful
	FALSE	the command was unsuccessful
slot:	Module slot in which the Anybus is fitted	
address:	Module address, node number, MAC id. Etc (Profibus only)	
type:	Data type and location	
	0	VR Integer
	1	Table Integer
	2	VR Float
	3	Table Float
inoff:	Offset for inputs	
outoff:	Offset for outputs	
endian	0	**Use default endian from network (default)**
	1	Swap endian

EXAMPLES:

EXAMPLE 1:

Configure Device Net with 2 16-bit integer inputs and 2 16-bit integer outputs. This data is transmitted cyclically using the 'Polled Connection' method. Ensure to configure the master identically to the slave otherwise the data will not transmit.

```
device_net:
  slotnum=0 'Local variable with module slot number

 'Map data
  map=FALSE
 'Map received data
  map= ANYBUS(0, slotnum, 1, 0, 0, 2, 4, 0) '4*16-bit Int Rx
  IF map=TRUE THEN
    'Map transmit data
    map= ANYBUS(0, slotnum, 2, 0, 4, 2, 4, 1) '4*16-bit Int Tx
  ENDIF

  IF map=FALSE THEN
    PRINT#term, "Mapping failed"
    STOP
  ENDIF
```

```
    'Print mapped data to the terminal
      ANYBUS(0,slotnum)

    'Start Network
      map= ANYBUS(1, slotnum, 3, 2)  'MAC ID=3, Baud=500k
      IF map=FALSE THEN
        PRINT#term, "Failed to start network"
        STOP
        ELSE
        PRINT#term, "Network Started"
      ENDIF
      RETURN
```

EXAMPLE 2:

Configure CC-Link with 2 stations, both with 16 bits in, 16 bits out, 2 SINT16 in and 2 SINT16 out. Ensure that the master is configured identically and that the handshaking bits are implemented.

```
    cc_link:
    'Function 0 - Set up mapping
    'station 1
      map = ANYBUS(0, slotnum, 0, 0, 0, 0, 16, 0) '16*BOOL Rx
      map = ANYBUS(0, slotnum, 1, 0, 1, 0, 16, 1) '16*BOOL Tx
      map = ANYBUS(0, slotnum, 2, 0, 2, 2, 2, 0)'2*16-bit Int Rx
      map = ANYBUS(0, slotnum, 3, 0, 4, 2, 2, 1) '2*16-bit Int Tx
    'station 2
      map = ANYBUS(0, slotnum, 4, 0, 6, 0, 16, 0) '16*BOOL Rx
      map = ANYBUS(0, slotnum, 5, 0, 7, 0, 16, 1) '16*BOOL Tx
      map = ANYBUS(0, slotnum, 6, 0, 8, 2, 2, 0) '2*16-bit Int Rx
      map = ANYBUS(0, slotnum, 7, 0, 10, 2, 2, 1) '2*16-bit Int Tx

      ANYBUS(0,slotnum) 'print mapping to terminal

    'Function 1 - Start Protocol
      IF map = FALSE THEN
      map = ANYBUS(1, slotnum, 1, 2)
      ENDIF
```

EXAMPLE 3:

Configure Profibus using the automated mapping.

```
    Profibus:
      vrint=0
      tableint=1
      vrfloat=2
      tablefloat=3
      slotnum=0

      'Function 4, read network mapping, configure and start.
      map=ANYBUS(4, slotnum, 5, vrint, 100, 200)

      IF map=FALSE THEN
        PRINT#term, «Failed to start network»
        STOP
      ENDIF
      ANYBUS(0,slotnum) 'print mapping to terminal
```

EXAMPLE 4:

Configure Profinet using the automated mapping.

```
    Profinet:
      vrint=0
      tableint=1
      vrfloat=2
      tablefloat=3
      slotnum=0

      'Function 4, read network mapping, configure and start.
      map=ANYBUS(4, slotnum, vrint, 100, 200)

      IF map=FALSE THEN
        PRINT#term, «Failed to start network»
        STOP
      ENDIF
```

AOUT

TYPE:

System Command

SYNTAX:

`AOUT(channel)`

DESCRIPTION:

Writes a value to an analogue output. Analogue outputs available from the CAN Analogue module.

The value sent is the decimal equivalent of the binary number to be written to the D to A converter.

PARAMETERS:

channel:	Analogue output channel number 0...15

EXAMPLE:

An output is to be set to the speed input of an open-loop inverter drive. 10V is 1500 rpm and the required speed is 300 rpm.

```
    value = 300 * 2048 / 1500
    AOUT(1) = value
```

The analogue output voltage is set to 2V.

The voltage is approximate and the output must be calibrated by the user if high accuracy is required.

AOUT0..3

TYPE:

System Parameter

DESCRIPTION:

These system parameters duplicate the **AOUT** command.

They provide the value of the analogue output channels in system parameter format to allow the **SCOPE** function (Which can only store parameters) to read the analogue outputs.

ASC

TYPE:

String Function

SYNTAX:

```
value = ASC("string")
```

DESCRIPTION:

ASC returns the **ASCII** value of the first character in the provided **STRING** parameter. If the **STRING** is empty then 0 will be returned.

PARAMETERS:

string:	Any valid **STRING**
value:	An integer value

EXAMPLES:

EXAMPLE 1:

Print the **ASCII** value of character 'A' contained within a longer **STRING**.

```
>>PRINT ASC("ABCDEF")
65
>>
```

EXAMPLE 2:

Print the **ASCII** value of character '9'.

```
>> PRINT ASC("9")
57
>>
```

SEE ALSO:

PRINT, STRING, CHR

ASIN

TYPE:

Mathematical Function

SYNTAX:

ASIN(expression)

ALTERNATE FORMAT:

ASN(expression)

DESCRIPTION:

The **ASIN** function returns the arc-sine of a number which should be in the range +/-1. The result in radians is in the range -PI/2.. +PI/2.

PARAMETERS:

Expression:	Any valid TrioBASIC expression returning a value between -1 and 1.

EXAMPLE:
Print the arc-sine of -1 on the command line

```
    >>PRINT ASIN(-1)
    -1.5708
```

ATAN

TYPE:
Mathematical Function

SYNTAX:
`ATAN(expression)`

ALTERNATE FORMAT:
`ATN(expression)`

DESCRIPTION:
The **`ATAN`** function returns the arc-tangent of a number. The result in radians is in the range -PI/2.. +PI/2

PARAMETERS:

Expression:	Any valid TrioBASIC expression

EXAMPLE:
Print the arc-tangent of -1 on the command line

```
    >>PRINT ATAN(1)
    0.7854
```

ATAN2

TYPE:
Mathematical Function

SYNTAX:

`ATAN2(expression1,expression2)`

DESCRIPTION:

The ATAN2 function returns the arc-tangent of the ratio expression1/expression2. The result in radians is in the range -PI.. +PI

Use **ATAN2** when calculating vectors as it is quicker to execute than **ATAN**(x/y)

PARAMETERS:

Expression1:	Any valid TrioBASIC expression.
Expression2:	Any valid TrioBASIC expression.

EXAMPLE:

Print the arc-tangent of 0 divided by 1 on the command line

```
    >>PRINT ATAN2(0,1)
    0.0000
```

ATYPE

TYPE:

Axis Parameter (**MC_CONFIG**)

DESCRIPTION:

The **ATYPE** axis parameter indicates the type of axis fitted. By default this will be set to match the hardware, but some modules allow configuration of different operation.

If you are setting an **ATYPE**, this must be done during initialisation through the **MC_CONFIG**.bas program.

When using **ATYPE** in MC_**CONFIG** you must use the **AXIS** modifier, **BASE** is not allowed.

VALUE:

The following **ATYPE**'s are currently active values

Value	Description
0	No axis daughter board fitted/ virtual axis
30	Analogue feedback Servo
43	Pulse and direction output with enable output

Value	Description
44	Incremental encoder Servo with Z input
45	Quadrature encoder output with enable output
46	Tamagawa absolute Servo
47	Endat absolute Servo
48	SSI absolute Servo
50	**`RTEX`** position
51	**`RTEX`** speed
52	**`RTEX`** torque
53	Sercos velocity
54	Sercos position
55	Sercos torque
56	Sercos open
57	Sercos velocity with drive registration
58	Sercos position with drive registration
59	Sercos spare
60	Pulse and direction feedback Servo with Z input
61	SLM
62	PLM
63	Pulse and direction output with Z input
64	Quadrature encoder output with Z input
65	EtherCAT position
66	EtherCAT speed
67	EtherCAT Torque
68	EtherCAT Open Speed
69	EtherCAT Reference Encoder
75	SSI 32 Absolute Slave
76	Incremental encoder with Z input

Value	Description
77	Incremental encoder Servo with enable output
78	Pulse and direction with **VFF_GAIN** and enable output
79	Pulse and direction feedback with Z input
84	Quadrature encoder output with **VFF_GAIN** and enable output
85	Used for monitoring difference between 2 axes with **AXESDIFF**
86	Tamagawa absolute (input only)
87	Endat absolute (input only)
88	SSI absolute (input only)

Which **ATYPE**s are supported is controller and module dependent.

EXAMPLES:

EXAMPLE 1:

Set a stepper on axis 0 and SSI encoder on axis 1. The default for a flexible axis is servo

```
BASE(0)
ATYPE = 43
BASE(1)
binary = 1
gray = 0
'Set the number of bits
ENCODER_BITS = 24
'Set gray or binary code
ENCODER_BITS.6 = gray
ATYPE = 48
```

EXAMPLE 2:

Set a the **ATYPE** so a Sercos axis uses velocity mode with drive registration

```
ATYPE AXIS(12)=57
```

EXAMPLE 3:

Setting the **ATYPE** for the first 4 axis in the **MC_CONFIG** file so that the first two axes are SSI and the rest incremental servo.

```
ATYPE AXIS(0) = 48
ATYPE AXIS(1) = 48
ATYPE AXIS(2) = 44
ATYPE AXIS(2) = 44
```

EXAMPLE 4:

Set a EnDAT encoder on **AXIS**(0).

```
    ENCODER_BITS=25+256*12
    ATYPE=47
```

EXAMPLE 5:

Set a Tamagawa encoder on **AXIS**(0). Remember you may need to change the **FPGA_PROGRAM** to use the Tamagawa encoder.

```
    ATYPE=46
```

AUTO_ETHERCAT

TYPE:

System Parameter (**MC_CONFIG**)

DESCRIPTION:

Controls the action of the system software on power up. If present, the EtherCAT network is initialized automatically on power up or soft reset (EX). If this is not required, then setting **AUTO_ETHERCAT** to OFF will prevent the EtherCAT from being set up and it is then up to the programmer to start the EtherCAT network from a **BASIC** program.

This command should not be used in a TrioBASIC program. You must use it in the special MC_**CONFIG** script which runs automatically on power up. This parameter is **NOT** stored in **FLASH**.

VALUE:

Value	Description
0	EtherCAT network does not initialise on power up.
1	EtherCAT network searches for drives and sets up the system automatically.

EXAMPLE:

Prevent the EtherCAT system from starting on power up.

```
    ' MC_CONFIG script file
    AUTO_ETHERCAT = OFF
```

AUTORUN

TYPE:
System Command

DESCRIPTION:
Starts running all the programs that have been set to run at power up.

This command should not be used in a TrioBASIC program. You can use it in the command line or a TRIO**INIT**.bas in a SD card.

EXAMPLE:
Using a **TRIOINIT**.bas file in a SD card to load and run a new project

```
    FILE "LOAD_PROJECT" "ROBOT_ARM"
    AUTORUN
```

AXESDIFF

TYPE:
Axis command

SYNTAX:
AXESDIFF(axis1, axis2)

DESCRIPTION:
The **AXESDIFF** command is used to configure the monitoring of 2 axes performed on an axis with **ATYPE**=85. An axis of **ATYPE**=85 will produce an **MPOS** output based on the difference between **MPOS** of 'axis2' subtracted from **MPOS** of 'axis1', a DAC output will also be produced.

The specified axis can be any axis and does not have to physically exist in the system

PARAMETER:

Axis1:	First Axis to monitor. -1 breaks the link with the other axis.
Axis2:	Second Axis to monitor. -1 breaks the link with the other axis.

EXAMPLES:

EXAMPLE 1:

To monitor axes 3 & 7.

```
    ATYPE=85
    AXESDIFF(3,7)
```

AXIS

TYPE:

Modifier (**MC_CONFIG**)

SYNTAX:

AXIS(expression)

DESCRIPTION:

Assigns ONE command, function or axis parameter operation to a particular axis.

If it is required to change the axis used in every subsequent command, the **BASE** command should be used instead.

PARAMETERS:

Expression:	Any valid TrioBASIC expression. The result of the expression should be a valid integer axis number.

EXAMPLES:

EXAMPLE 1:

The command line has a default base axis of 0. To print the measured position of axis 3 to the terminal in *Motion* Perfect, you must add the axis number after the parameter name.

```
    >>PRINT MPOS AXIS(3)
```

EXAMPLE 2:

The base axis is 0, but it is required to start moves on other axes as well as the base axis.

```
    MOVE(450)    'Start a move on the base axis (axis 0)
    MOVE(300) AXIS(2)     'Start a move on axis 2
    MOVEABS(120) AXIS(5)  'Start an absolute move on axis 5
```

EXAMPLE 3:

Set up the repeat distance and repeat option on axis 3, then return to using the base axis for all later commands.

```
    REP_DIST AXIS(3)=100
    REP_OPTION AXIS(3)=1
    SPEED=2.30 'set speed accel and decel on the BASE axis
    ACCEL=5.35
    DECEL=8.55
```

SEE ALSO:
BASE()

AXIS_A_OUTPUT

TYPE:
Reserved Keyword

AXIS_ADDRESS

TYPE:
Axis Parameter (**MC_CONFIG**)

DESCRIPTION:
The **AXIS_ADDRESS** parameter holds the address of the drive or feedback device. For example can be used to specify the Sercos drive address or AIN channel that is used for feedback on the base axis.

VALUE:
Drive address / node number or analogue input number

You may require additional Feature Enable Codes before using the remote axis functionality.

EXAMPLE:
Assigning the Sercos drive with the node address 4 to axis 8 in the controller. Then starting it in position mode with drive registration.

```
    BASE(8)
    AXIS_ADDRES = 4
    ATYPE = 58
```

AXIS_B_OUTPUT

TYPE:
Reserved Keyword

AXIS_DEBUG_A

TYPE:
Reserved Keyword

DESCRIPTION:
Use only when instructed by Trio as part of an operational analysis.

AXIS_DEBUG_B

TYPE:
Reserved Keyword

DESCRIPTION:
Use only when instructed by Trio as part of an operational analysis.

AXIS_DISPLAY

TYPE:
Reserved Keyword

AXIS_DPOS

TYPE:
Axis Parameter (Read Only)

ALTERNATE FORMAT:
`TRANS_DPOS`

DESCRIPTION:

AXIS_DPOS is the axis demand position at the output of the **FRAME** transformation.

AXIS_DPOS is normally equal to **DPOS** on each axis. The frame transformation is therefore equivalent to 1:1 for each axis (**FRAME** = 0). For some machinery configurations it can be useful to install a frame transformation which is not 1:1, these are typically machines such as robotic arms or machines with parasitic motions on the axes. In this situation when **FRAME** is not zero **AXIS_DPOS** returns the demand position for the actual motor.

AXIS_DPOS is set to **MPOS** when **SERVO** or **WDOG** are OFF

VALUE:

The axis demand position at the output of the **FRAME** transformation in **AXIS_UNITS**. Default 0 on power up.

EXAMPLE:

Return the axis position in user **AXIS_UNITS** using the command line.

```
    >>PRINT AXIS_DPOS
    125.22
    >>
```

SEE ALSO:

AXIS_UNITS, FRAME

AXIS_ENABLE

TYPE:

Axis Parameter

DESCRIPTION:

Can be used to independently disable an axis. ON by default, can be set to OFF to disable the axis. The axis is enabled if **AXIS_ENABLE** = ON and **WDOG** = ON.

On stepper axis **AXIS_ENABLE** will turn on the hardware enable outputs.

If the axis is part of a **DISABLE_GROUP** and an error occurs **AXIS_ENABLE** is set to **OFF** but the **WDOG** remains **ON**.

VALUE:

Accepts the values ON or OFF, default is ON.

EXAMPLE:

Re-enabling a group of axes after a motion error

```
    DEFPOS(0)          'Clear the error
    For axis_number = 4 to 8
    BASE(axis_number)
    AXIS_ENABLE = ON   'Enable the axis
    NEXT axis_number
```

SEE ALSO:

DISABLE_GROUP

AXIS_ERROR_COUNT

TYPE:

Axis Parameter.

DESCRIPTION:

Each time there is a communications error on a digital axis, the **AXIS_ERROR_COUNT** parameter is incremented. Where supported, this value can be used as an indication of the error rate on a digital axis. Not all digital axis types have the ability to count the errors. Further information can be found in the description of each type of digital communications bus.

VALUE:

The communications error count since last reset.

EXAMPLE:

Initialise the error counter

```
    AXIS_ERROR_COUNT = 0
```

In the terminal, check the latest error count value.

```
    >>?AXIS_ERROR_COUNT AXIS(3)
    10.0000
    >>
```

Keep a record of the overall error rate for an axis.

```
    TICKS = 600000
    AXIS_ERROR_COUNT = 0
    REPEAT
      IF TICKS<0 THEN
        VR(10) = AXIS_ERROR_COUNT ' number of errors counted in ten minutes
        TICKS = 600000
        AXIS_ERROR_COUNT = 0
      ENDIF
      …
      …
    UNTIL FALSE
```

AXIS_FS_LIMIT

TYPE:

Axis Parameter

DESCRIPTION:

An end of travel limit may be set up in software thus allowing the program control of the working range of an axis. This parameter holds the absolute position of the forward travel limit in user **AXIS_UNITS**.

Bit 16 of the **AXISSTATUS** register is set when the axis position is greater than the **AXIS_FS_LIMIT**.

Axis software limits are only enabled when **FRAME**<>0 so that the user can limit the range of motion of the motor/ joint.

When **AXIS_DPOS** reaches **AXIS_FS_LIMIT** the controller will **CANCEL** all moves on the **FRAME_GROUP**, the axis will decelerate at **DECEL** or **FASTDEC**. Any **SYNC** is also stopped. As this software limit uses **AXIS_DPOS** it will require a negative change in **AXIS_DPOS** to move off the limit. This may not be a negative movement on **DPOS** due to the selected **FRAME** transformation..

AXIS_FS_LIMIT is disabled when it has a value greater than **REP_DIST** or when **FRAME**=0.

VALUE:

The absolute position of the software forward travel limit in user **UNITS**. (default = 200000000000)

EXAMPLES:

Set up an axis software limit so that the axis operates between 180 degrees and 270 degrees. The encoder returns 4000 counts per revolution.

```
AXIS_UNITS=4000/360
AXIS_FS_LIMIT=270
AXIS_RS_LIMIT=180
```

SEE ALSO:

AXIS_DPOS, AXIS_RS_LIMIT, AXIS_UNITS, FS_LIMIT, FWD_IN, REV_IN, RS_LIMIT

AXIS_MODE

TYPE:

Axis Parameter

DESCRIPTION:

This parameter enables various different features that an axis can use.

VALUE:

Bit	Description	Value
1	Prevents **CONNECT** from canceling when a hardware or software limit is reached, the ratio is set to 0.	2
2	Enable 3D direction calculations (default 2D)	4
6	Use non sign-extended analogue feedback	64

EXAMPLES:

EXAMPLE 1:
Enable bit 2 so that you can use 3D direction calculations, the AND is used so that only bit 2 is changed.

```
AXIS_MODE AXIS(18) = AXIS_MODE AXIS(18) AND 4
```

EXAMPLE 2:
Enable bit 6 so that you can use a 0 to 10V analogue input as axis feedback. The AND is used so that only bit 6 is changed.

```
BASE(5)
AXIS_MODE = AXIS_MODE AND 64
```

SEE ALSO:
ERRORMASK, **DATUM(0)**

AXIS_OFFSET

TYPE:
Slot Parameter (**MC_CONFIG** / **FLASH**)

DESCRIPTION:
AXIS_OFFSET is the first axis number that a slot tries to assign its axis to. If the axis is already being used (its **ATYPE** is non zero) then the axis is assigned to the next free axis. The controller will assign the axis depending on their SLOTs and the module type as per the following sequence:

1. EtherCAT and Panasonic axis will be assigned by **SLOT** to the first available axis starting at **AXIS_OFFSET** (plus node address -1 for Ethercat)
2. Then FlexAxis will be assigned by **SLOT** to the first available axis starting at **AXIS_OFFSET**
3. The built in axis is assigned to the first available axis starting at **AXIS_OFFSET**
4. Finally any BASIC axis are assigned as per the BASIC program. This includes **SLM** and **SERCOS** as well as any EtherCAT or Panasonic axis that is configured in BASIC.

The axis assignment is only performed on power up. **AXIS_OFFSET** should be put in the MC_**CONFIG** script to take effect immediately.

VALUE:

The first axis that the module tries to assign its axis to, range = 0 to max axis, default = 0.

EXAMPLES:

EXAMPLE 1:

```
SLOT -1 = built in, AXIS_OFFSET=0
SLOT 0 = EtherCAT, 4 axis, no node addresses set, AXIS_OFFSET=0
AXIS(0-3) Ethercat
AXIS(4) Built in
AXIS_OFFSET SLOT(0)=0
AXIS_OFFSET SLOT(-1)=0
```

This is the default case.

EXAMPLE 2:

```
SLOT -1 = built in, AXIS_OFFSET=2
SLOT 0 = EtherCAT, 4 axis, no node addresses set, AXIS_OFFSET=0
AXIS(0-3) Ethercat
AXIS(4) Built in
AXIS_OFFSET SLOT(0)=0
AXIS_OFFSET SLOT(-1)=2
```

The built in is still last as it is assigned last, the controller tries to assign the built in axis to the ***first*** available axis from 2 which is 4.

EXAMPLE 3:

```
SLOT -1 = built in, AXIS_OFFSET=0
SLOT 0 = EtherCAT, 4 axis, no node addresses set, AXIS_OFFSET=1
AXIS(0) Built in
AXIS(1-4) Ethercat
AXIS_OFFSET SLOT(0)=1
AXIS_OFFSET SLOT(-1)=0
```

The offset pushes the Ethercat out one axis so **AXIS**(0) is still spare when the built in axis is assigned

EXAMPLE 4:

```
SLOT -1 = built in, AXIS_OFFSET=0
SLOT 0 = EtherCAT, 4 axis, node switches on the drives set to 2, 3, 4,
5, AXIS_OFFSET=0
AXIS(0) Built in
```

```
    AXIS(1-4) Ethercat
    AXIS_OFFSET SLOT(0)=0
    AXIS_OFFSET SLOT(-1)=0
```

The EtherCAT axis are set from their node address-1+**AXIS_OFFSET**

EXAMPLE 5:

```
    SLOT -1 = built in, AXIS_OFFSET=0
    SLOT 0 = EtherCAT, 4 axis, nodes set to 2, 3, 4, 5, AXIS_OFFSET=1
    AXIS(0) Built in
    AXIS(2-5) Ethercat
    AXIS_OFFSET SLOT(0)=1
    AXIS_OFFSET SLOT(-1)=0
```

The EtherCAT axis are set from their node address-1+**AXIS_OFFSET**

EXAMPLE 6:

```
    SLOT -1 = built in, AXIS_OFFSET=0
    SLOT 0 = FlexAxis, 8 axis module, AXIS_OFFSET=1
    AXIS(0) Built in
    AXES(1-8) FlexAxis
    AXIS_OFFSET SLOT(-1)=0
    AXIS_OFFSET SLOT(0)=1
```

AXIS_RS_LIMIT

TYPE:

Axis Parameter

DESCRIPTION:

An end of travel limit may be set up in software thus allowing the program control of the working range of an axis. This parameter holds the absolute position of the reverse travel limit in user **AXIS_UNITS**.

Bit 17 of the **AXISSTATUS** register is set when the axis position is less than the **AXIS_RS_LIMIT**.

Axis software limits are only enabled when **FRAME**<>0 so that the user can limit the range of motion of the motor/ joint.

When **AXIS_DPOS** reaches **AXIS_RS_LIMIT** the controller will **CANCEL** all moves on the **FRAME_GROUP**, the axis will decelerate at **DECEL** or **FASTDEC**. Any **SYNC** is also stopped. As this software limit uses **AXIS_DPOS** it will require a positive change in **AXIS_DPOS** to move off the limit. This may not be a positive movement on **DPOS** due to the selected **FRAME** transformation..

AXIS_RS_LIMIT is disabled when it has a value greater than **REP_DIST** or when *FRAME*=0.

VALUE:
The absolute position of the software forward travel limit in user **UNITS**. (default = 200000000000)

EXAMPLES:
An arm on a robots joint can move 90degrees. The encoder returns 400 counts per revolution and there is a 50:1 gearbox

```
AXIS_UNITS=4000*50/360
AXIS_FS_LIMIT=0
AXIS_RS_LIMIT=90
```

SEE ALSO:
AXIS_DPOS, **AXIS_FS_LIMIT**, **AXIS_UNITS**, **FS_LIMIT**, **FWD_IN**, **REV_IN**, **RS_LIMIT**

The built-in axis would normally be put after the Flexaxis. Here the Flexaxis is forced to start at axis 1, therefore the built-in axis can take axis 0.

AXIS_UNITS

TYPE:
Axis Parameter

DESCRIPTION:
AXIS_UNITS is a conversion factor that allows the user to scale the edges/ stepper pulses to a more convenient scale. **AXIS_UNITS** is only used when a **FRAME** is active and only applies to the parameters in the axis coordinate system (after the **FRAME**). This includes **AXIS_DPOS**, **AXIS_FS_LIMIT**, **AXIS_RS_LIMIT** and **MPOS**.

MPOS will use **UNITS** when **FRAME** =0 and **AXIS_UNITS** when **FRAME** <> 0

VALUE:
The number of counts per required units (default =1). Examples:

EXAMPLE:
A motor on a robot has an 18bit encoder and uses an 18bit encoder and 31:1 ratio gearbox. To simplify reading **AXIS_DPOS** the user wants to use radians.

```
encoder_bits = 2^10
```

```
    gearbox_ratio = 31
    radians_conversion=2*PI
    AXIS_UNITS=( encoder_bits * gearbox_ratio)/ radians_conversion
```

SEE ALSO:
AXIS_DPOS, **UNITS**

AXIS_Z_OUTPUT

TYPE:
Reserved Keyword

AXISSTATUS

TYPE:
Axis Parameter (Read Only)

DESCRIPTION:
The **AXISSTATUS** axis parameter may be used to check various status bits held for each axis fitted:

VALUE:
21 bit value, each bit represents a different status bit.

Bit	Description	Value	char
0	Speed limit active	1	l
1	Following error warning range	2	w
2	Communications error to remote drive	4	a
3	Remote drive error	8	m
4	In forward hardware limit	16	f
5	In reverse hardware limit	32	r
6	Datuming in progress	64	d
7	Feedhold active	128	h
8	Following error exceeds limit	256	e
9	**FS_LIMIT** active	512	x

Bit	Description	Value	char
10	**RS_LIMIT** active	1024	y
11	Canceling move	2048	c
12	Pulse output axis overspeed	4096	o
13	**MOVETANG** decelerating	8192	t
15	**VOLUME_LIMIT** active	32768	v
16	**AXIS_FS_LIMIT** active	65536	i
17	**AXIS_RS_LIMIT** active	131072	j
18	Encoder power supply overload	262144	p
19	**HW_PSWITCH FIFO** not empty	524288	n
20	**HW_PSWITCH FIFO** full	1048576	b

Motion Perfect uses the characters to display the error in the Axis Parameters window.

EXAMPLES:

EXAMPLE 1:
Check bit 4 to see if the axis is in forward limit.

```
IF (AXISSTATUS AND 16)>0 THEN
  PRINT "In forward limit"
ENDIF
```

EXAMPLE 2:
Check bit 3 to see if there is a remote drive error.

```
IF AXISSTATUS.3 = ON THEN
  PRINT "Remote drive error"
ENDIF
```

SEE ALSO:
ERRORMASK, DATUM(0)

AXISVALUES

TYPE:
`AXIS` Command

SYNTAX:
`AXISVALUES(axis,bank)`

DESCRIPTION:
Used by *Motion* Perfect to read a bank of axis parameters.

The data is returned in the format:

<Parameter> <type>=<value>

<Parameter> is the name of the parameter

<type> is the type of the value:

i	integer
F	float
S	string
C	string of upper and lower case letters, where upper case letters mean an error

<value> is an integer, a float or a string depending on the type

PARAMETERS:

axis:	the axis number where you want to read the parameters	
bank:	the bank of parameters that you wish to read.	
	0	displays the data that is only adjusted through the TrioBASIC
	1	displays the data that is changed by the motion generator.

B_SPLINE

TYPE:
Command

SYNTAX:
`B_SPLINE(mode, {parameters})`

DESCRIPTION:
This function expands data to generate higher resolution motion profiles. It operates in two modes using either B Spline or Non Uniform Rational B Spline (**NURBS**) mathematical methods.

PARAMETERS:

mode:	1	Standard B-Spline
	2	Non-uniform Rational B-Spline

MODE = 1:

SYNTAX:
`B_SPLINE(1, data_in, points, data_out, expansion_ratio)`

DESCRIPTION:
Expands an existing profile stored in the **TABLE** area using the B Spline mathematical function. The expansion factor is configurable and the **B_SPLINE** stores the expanded profile to another area in the **TABLE**.

This is ideally used where the source **CAM** profile is too coarse and needs to be extrapolated into a greater number of points.

PARAMETERS:

data_in:	Location in the **TABLE** where the source profile is stored.
points:	Number of points in the source profile.
data_out:	Location in the **TABLE** where the expanded profile will be stored.

expansion_ratio:	The expansion ratio of the **B_SPLINE** function. Total output points = (Number of points+1) * expansion (i.e. if the source profile is 100 points and the expansion ratio is set to 10 the resulting profile will be 1010 point ((100+1) * 10).

EXAMPLE:

Expands a 10 point profile in **TABLE** locations 0 to 9 to a larger 110 point profile starting at **TABLE** address 200.

```
    B_SPLINE(1,0,10,200,10)
```

MODE = 2:

SYNTAX:

```
B_SPLINE(2, dimensions, curve_type, weight_op, points, knots, expansion,
in_data, out_data)
```

DESCRIPTION:

Non Uniform Rational B-Splines, commonly referred to as **NURBS**, have become the industry standard way of representing geometric surface information designed by a CAD system

NURBS provide a unified mathematical basis for representing analytic shapes such as conic sections and quadratic surfaces, as well as free form entities, such as car bodies and ship hulls.

NURBS are small for data portability and can be scaled to increase the number of target points along a curve, increasing accuracy. A series of **NURBS** are used to describe a complex shape or surface.

NURBS are represented as a series of XYZ points with knots + weightings of the knots.

PARAMETERS:

dimensions:	Defines the number of axes. Reserved for future use must be 3.
curve_type:	Classification of the type of **NURBS** curve. Reserved for future use must be 3.
weight_op:	Sets the weighting of the knots 0 = All weighting set to 1.
knots:	Number of knots defined.
points:	Number of data points.
expansion:	Defines the number of points the expanded curve will have in the table. Total output points = Number of points * expansion. Minimum value = 3.

in_data:	Location of input data.
out_data:	Table start location for output points stored X0, Y0, Z0 etc.

EXAMPLE:

Starting with 9 sets of X Y Z data point and expanding by 5, resulting with 45 sets of X Y Z data points (135 table points). The profile is then split from the XYZ groups into separate axis so that the profiles can be executed using **CAMBOX**.

```
weight_op=0    '0 sets all weights to 1.0
points=9       'number of data points
knots=13       'number of knots
expansion=5    'expansion factor
in_data=100    'data points
out_data=1000  'table location to construct output

'Data Points:
TABLE(100,150.709,353.8857,0)
TABLE(103,104.5196,337.7142,0)
TABLE(106,320.1131,499.4647,0)
TABLE(109,449.4824,396.4945,0)
TABLE(112,595.3350,136.4910,0)
TABLE(115,156.816,96.3351,0)
TABLE(118,429.4556,313.7982,0)
TABLE(121,213.3019,375.8004,0)
TABLE(124,150.709,353.8857,0)

'Knots:
TABLE,0,0,0,0,146.8154,325.6644,536.0555,763.4151,910.1338,1109.0886)
TABLE(137,1109.0886,1109.0886,1109.0886)

'Expand the curve, generate 5*9=45 XYZ points
'or 135 table locations

B_SPLINE(2, 3, 3, weight_op, points, knots, expansion, in_data, out_
data)

'Split the profile into X Y Z
FOR p= 0 TO 44
    TABLE(8000+p,TABLE(1000+(p*3)+0))
    TABLE(10000+p,TABLE(1000+(p*3)+1))
    TABLE(12000+p,TABLE(1000+(p*3)+2))
NEXT p

'Execute the profile using CAMBOX, synchronised using axis 4
```

```
BASE(0)
DEFPOS(0,0,0,0)
CAMBOX(8000,8044,1,100,4)
BASE(1)
CAMBOX(10000,10044,1,100,4)
BASE(2)
CAMBOX(12000,12044,1,100,4)
BASE(4)
MOVE(100)
```

BACKLASH

TYPE:
Axis Command

SYNTAX:
`BACKLASH(enable [,distance, speed, acceleration])`

DESCRIPTION:
This axis function allows backlash compensation to be loaded. This is achieved by applying an offset move when the motor demand is in one direction, then reversing the offset move when the motor demand is in the opposite direction. These moves are superimposed on the commanded axis movements.

The backlash compensation is applied after a reversal of the direction of change of the **DPOS** parameter.

The backlash compensation can be seen in the **AXIS_DPOS** axis parameter. This is effectively **DPOS** + backlash compensation.

PARAMETERS:

enable:	ON to enable **BACKLASH**
	OFF to disable **BACKLASH**
distance:	The distance to be offset in user units
speed:	The speed at which is the compensation move is applied in user units
acceleration:	The **ACCEL**/**DECEL** rate at which is compensation move is applied in user units

EXAMPLES

EXAMPLE 1:
```
    'Apply backlash compensation on axes 0 and 1:
    BACKLASH(ON,0.5,10,50) AXIS(0)
    BACKLASH(ON,0.4,8,50) AXIS(1)
```

EXAMPLE 2:
```
    'Turn off backlash compensation on axis 3:
    BASE(3)
    BACKLASH(OFF)
```

SEE ALSO:
AXIS_DPOS

BACKLASH_DIST

TYPE:
Axis Parameter

DESCRIPTION:
Amount of backlash compensation that is being applied to the axis when **BACKLASH** is ON.

EXAMPLE:
Illuminate a lamp to show that the backlash has been compensated for.
```
    IF BACKLASH_DIST>100 THEN
      OP (10, ON)   'show that backlash compensation has reached
                    'this value
    ELSE
      OP (10, OFF)
    END IF
```

SEE ALSO:
BACKLASH

BASE

TYPE:
Process Command

SYNTAX:

`BASE(axis no<,second axis><,third axis>...)`

ALTERNATE FORMAT:

`BA(...)`

DESCRIPTION:

The **BASE** command is used to direct all subsequent motion commands and axis parameter read/writes to a particular axis, or group of axes. The default setting is a sequence: 0, 1, 2, 3...

Each process has its own **BASE** group of axes and each program can set **BASE** values independently. So the **BASE** array will be different for each of your programs and the command line.

The values are stored in an array, when you adjust **BASE** the controller will automatically fill in the remaining positions by continuing the sequence and then adding the missed values at the end.

The **BASE** array can be printed on the command line by simply entering **BASE**

PARAMETERS:

axis numbers:	The number of the axis or axes to become the new base axis array, i.e. the axis/axes to send the motion commands to or the first axis in a multi axis command.

The **BASE** array must use ascending values

EXAMPLES:

EXAMPLE 1:

Setting the base array to non sequential values and printing them back on the command line. This example uses a 16 axis controller.

The controller automatically continues the sequence with 10 and then fills in the missed values at the end of the list.

```
>>BASE(1,5,9)
>>BASE
(1, 5, 9, 10, 11, 12, 13, 14, 15, 0, 2, 3, 4, 6, 7, 8)
>>
```

EXAMPLE 2:

Set up calibration units, speed and acceleration factors for axes 1 and 2.

```
BASE(1)
UNITS=2000     'unit conversion factor
SPEED=100      'Set speed axis 1 (units/sec)
```

```
    ACCEL=5000      `acceleration rate (units/sec/sec)
    BASE(2)
    UNITS=2000      `unit conversion factor
    SPEED=125       `Set speed axis 2
    ACCEL=10000     `acceleration rate
```

EXAMPLE 3:

Set up an interpolated move to run on axes; 0 (x), 6 (y) and 9 (z). Axis 0 will move 100 units, axis 6 will move -23.1 and axis 9 will move 1250 units. The axes will move along the resultant path at the speed and acceleration set for axis 0.

```
    BASE(0,6,9)
    SPEED=120
    ACCEL=2000
    DECEL=2500
    MOVE(100,-23.1,1250)
```

SEE ALSO:

AXIS()

BASICERROR

TYPE:

System Command

DESCRIPTION:

This command is used as part of an ON... **GOSUB** or ON... **GOTO**. This lets the user handle program errors. If the program ends for a reason other than normal stopping then the subroutine is executed, this is when **RUN_ERROR**<>31.

You should include the BASIC**ERROR** statement as the first line of the program

EXAMPLE:

When a program error occurs, print the error to the terminal and record the error number in a **VR** so that it can be displayed on an HMI through Modbus.

```
    ON BASICERROR GOTO error_routine
    ....(rest of program)

    error_routine:
      VR(100) = RUN_ERROR
      PRINT "The error ";RUN_ERROR[0];
      PRINT " occurred in line ";ERROR_LINE[0]
    STOP
```

SEE ALSO:
`RUN_ERROR, ERROR_LINE`

BATTERY_LOW

TYPE:
System Parameter (Read only)

DESCRIPTION:
This parameter returns the condition of the non-rechargeable battery.

VALUE:

0	Battery voltage is OK
1	Battery voltage is low and needs replacing

. Bit number

TYPE:
Mathematical operator

SYNTAX:
`<expression1>.bit_number`

DESCRIPTION:
Returns the value of the specified bit of the expression.

As . can be used as a decimal point be careful that you only use it with an expression. There should be no spaced between the expression and the .bit_number.

PARAMETERS:

Expression1:	Any valid TrioBASIC expression
bit_number:	The bit number of the expression to return

EXAMPLES:

EXAMPLE 1:

Check the **AXISSTATUS** for remote drive errors, bit3

```
IF AXISSTATUS.3 = 1 THEN
  PRINT "Remote drive error"
ENDIF
```

EXAMPLE2:

Set **VR**(10) to 54.2, then read bit 2 of 54.

```
VR(10) = 54.2
PRINT (54).2
```

BOOT_LOADER

TYPE:

System Command (command line only)

DESCRIPTION:

Used by *Motion* Perfect to enter the boot loader software.

Do not use unless instructed by Trio or a Distributor.

BREAK_ADD

TYPE:

System Command (command line only)

SYNTAX:

```
BREAK_ADD "program name" line_number
```

DESCRIPTION:

Used by *Motion* Perfect to insert a break point into the specified program at the specified line number.

If there is no code at the given line number **BREAK_ADD** will add the breakpoint at the next available line of code. i.e. If line 8 is empty but line 9 has "**NEXT** x" and a **BREAK_ADD** is issued for line 8, the break point will be added to line 9.

If a non existent line number is selected (i.e. line 50 when the program only has 40 lines), the controller will return an error.

PARAMETERS:

program name:	the name of any program existing on your controller
line_number:	the line umber where to insert the breakpoint

EXAMPLE:

Add a break point at line 8 of program “simpletest”

```
    BREAK_ADD “simpletest” 8
```

BREAK_DELETE

TYPE:

System Command (command line only)

SYNTAX:

```
BREAK_DELETE “program name” line_number
```

DESCRIPTION:

Used by *Motion* Perfect to remove a break point from the specified program at the specified line number.

If a non existent line number is selected (i.e. line 50 when the program only has 40 lines), the controller will return an error.

PARAMETERS:

program name:	the name of any program existing on your controller
line_number:	the line umber where to remove the breakpoint

EXAMPLE:

Remove the break point at line 8 of program “simpletest”

```
    BREAK_DELETE “simpletest” 8
```

BREAK_LIST

TYPE:
System Command (command line only)

SYNTAX:
```
    BREAK_LIST "program name"
```

DESCRIPTION:
Used by *Motion* Perfect to returns a list of all the break points in the given program name. The program name, line number and the code associated with that line is displayed.

PARAMETERS:

program name:	the name of any program existing on your controller

EXAMPLE
Show the breakpoints from a program called "simpletest" with break points inserted on lines 8 and 11.
```
    >>BREAK_LIST "simpletest"

    Program: SIMPLETEST
    Line 8: SERVO=ON
    Line 11: BASE(0)
```

BREAK_RESET

TYPE:
System Command (command line only)

SYNTAX:
```
BREAK_RESET "program name"
```

DESCRIPTION:
Used by *Motion* Perfect to remove all break points from the specified program.

PARAMETERS:

program name:	the name of any program existing on your controller

EXAMPLE:

Remove all break points from program “simpletest”

```
    BREAK_RESET “simpletest”
```

CAM

TYPE:

Axis Command

SYNTAX:

`CAM(start point, end point, table multiplier, distance)`

DESCRIPTION:

The CAM command is used to generate movement of an axis according to a table of positions which define a movement profile. The table of values is specified with the **TABLE** command. The movement may be defined with any number of points from 3 up to the maximum table size available. The controller performs linier interpolation between the values in the table to allow small numbers of points to define a smooth profile.

The **TABLE** values are translated into positions by offsetting them by the first value and then multiplying them by the multiplier parameter. This means that a non-zero starting profile will be offset so that the first point is zero and then all values are scaled with the multiplier. These are then used as absolute positions from the start position.

Two or more **CAM** commands executing simultaneously can use the same values in the table.

The speed of the CAM profile is defined through the **SPEED** of the **BASE** axis and the distance parameter. You can use these two values to determine the time taken to execute the CAM profile.

As with any motion command the **SPEED** may be changed at any time to any positive value. The **SPEED** is ramped up to using the current **ACCEL** value.

To obtain a CAM shape where **ACCEL** has no effect the value should be set to at least 1000 times the **SPEED** value (assuming the default **SERVO_PERIOD** of 1ms).

When the CAM command is executing, the **ENDMOVE** parameter is set to the end of the **PREVIOUS** move

PARAMETERS:

start point:	The start position of the cam profile in the **TABLE**
end point:	The end position of the cam profile in the **TABLE**
multiplier:	The table values are multiplied by this value to generate the positions.
distance:	The distance parameter relates the speed of the axis to the time taken to complete the cam profile. The time taken can be calculated using the current axis speed and this distance parameter (which are in user units).

EXAMPLES:

EXAMPLE 1:

A system is being programmed in mm and the speed is set to 10mm/sec. It is required to take 10 seconds to complete the profile, so a distance of 100mm should be specified.

```
SPEED = 10    'axis SPEED
time = 10     'time to complete profile
distance = SPEED* time  'distance parameter for CAM
CAM(0, 100, 1, distance)
```

EXAMPLE2:

Motion is required to follow the **POSITION** equation:

t(x) = x*25 + 10000(1-cos(x))

Where x is in degrees. This example table provides a simple oscillation superimposed with a constant speed. To load the table and cycle it continuously the program would be:

```
FOR deg=0 TO 360 STEP 20   'loop to fill in the table
  rad = deg * 2 * PI/360   'convert degrees to radians
  x = deg * 25 + 10000 * (1-COS(rad))
  TABLE(deg/20,x)          'place value of x in table
NEXT deg

WHILE IN(2)=ON   'repeat cam motion while input 2 is on
  CAM(0,18,1,200)
  WAIT IDLE
WEND
```

The subroutine camtable loads the data into the cam **TABLE**, as shown in the graph below.

Table Position	Degrees	Value
1	0	0
2	20	1103
3	40	3340
4	60	6500
5	80	10263
6	100	14236
7	120	18000
8	140	21160

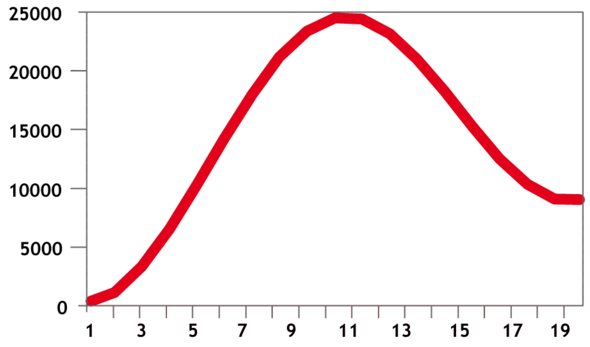


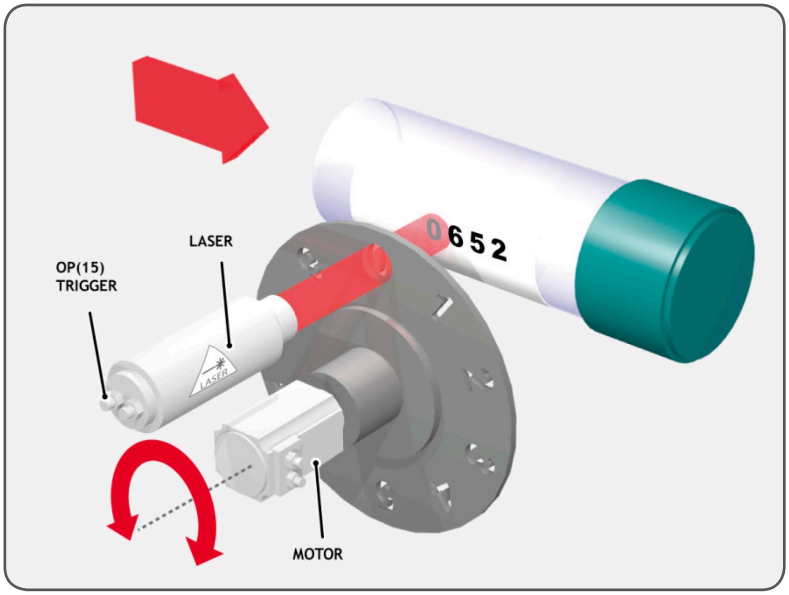
Table Position	Degrees	Value
9	160	23396
10	180	24500
11	200	24396
12	220	23160
13	240	21000
14	260	18236
15	280	15263
16	300	12500
17	320	10340
18	340	9103
19	360	9000

EXAMPLE 3:

A masked wheel is used to create a stencil for a laser to shine through for use in a printing system for the ten numerical digits. The required digits are transmitted through port 1 serial port to the controller as **`ASCII`** text.

The encoder used has 4000 edges per revolution and so must move 400 between each position. The cam table goes from 0 to 1, which means that the CAM multiplier needs to be a multiple of 400 to move between the positions.

The wheel is required to move to the pre-set positions every 0.25 seconds. The speed is set to 10000 edges/second, and we want the profile to be complete in 0.25 seconds. So multiplying the axis speed by the required completion time (10000 x 0.25) gives the distance parameter equals 2500.



```
GOSUB profile_gen
WHILE IN(2)=ON
  WAIT UNTIL KEY#1          'Waits for character on port 1
  GET#1,k
  IF k>47 AND k<58 THEN     'check for valid ASCII character
    position=(k-48)*400     'convert to absolute position
    multiplier=position-offset   'calculate relative movement
    'check if it is shorter to move in reverse direction
    IF multiplier>2000 THEN
      multiplier=multiplier-4000
    ELSEIF multiplier<-2000 THEN
      multiplier=multiplier+4000
    ENDIF
    CAM(0,200,multiplier,2500)    'set the CAM movment
    WAIT IDLE
    OP(15,ON)                     'trigger the laser flash
    WA(20)
    OP(15,OFF)
    offset=(k-48)*400   'calculates current absolute position
  ENDIF
WEND

profile_gen:
  num_p=201
  scale=1.0
  FOR p=0 TO num_p-1
    TABLE(p,((-SIN(PI*2*p/num_p)/(PI*2))+p/num_p)*scale)
  NEXT p
  RETURN
```

EXAMPLE 4:

A suction pick and place system must vary its speed depending on the load carried. The mechanism has a load cell which inputs to the controller on the analogue channel (AIN).

The move profile is fixed, but the time taken to complete this move must be varied depending on the AIN. The AIN value varies from 100 to 800, which has to result in a move time of 1 to 8 seconds. If the speed is set to 10000 units per second and the required time is 1 to 8 seconds, then the distance parameter must range from 10000 to 80000. (distance = speed x time)

The return trip can be completed in 0.5 seconds and so the distance value of 5000 is fixed for the return movement. The Multiplier is set to -1 to reverse the motion.

```
    GOSUB profile_gen       'loads the cam profile into the table
    SPEED=10000:ACCEL=SPEED*1000:DECEL=SPEED*1000
    WHILE IN(2)=ON
      OP(15,ON)             'turn on suction
      load=AIN(0)           'capture load value
      distance = 100*load   'calculate the distance parameter
      CAM(0,200,50,distance)  'move 50mm forward in time calculated
      WAIT IDLE
      OP(15,OFF)            'turn off suction
      WA(100)
      CAM(0,200,-50,5000)   'move back to pick up position
    WEND

    profile_gen:
      num_p=201
      scale=400     'set scale so that multiplier is in mm
      FOR p=0 TO num_p-1
        TABLE(p,((-SIN(PI*2*p/num_p)/(PI*2))+p/num_p)*scale)
      NEXT p
      RETURN
```

CAMBOX

TYPE:

Axis Command

SYNTAX:

```
CAMBOX(start_point, end_point, table_multiplier, link_distance , link_
axis[, link_options][, link_pos][, offset_start])
```

DESCRIPTION:

The **CAMBOX** command is used to generate movement of an axis according to a table of **POSITIONS** which define the movement profile. The motion is linked to the measured motion of another axis to form a continuously variable software gearbox. The table of values is specified with the **TABLE** command. The movement may be defined with any number of points from 3 up to the maximum table size available. The controller interpolates between the values in the table to allow small numbers of points to define a smooth profile.

The **TABLE** values are translated into positions by offsetting them by the first value and then multiplying them by the multiplier parameter. This means that a non-zero starting profile will be offset so that the first point is zero and then all values are scaled with the multiplier. These are then used as absolute positions from the start position.

Two or more **CAMBOX** commands executing simultaneously can use the same values in the table.

When the **CAMBOX** command is executing the **ENDMOVE** parameter is set to the end of the **PREVIOUS** move. The **REMAIN** axis parameter holds the remainder of the distance on the link axis.

PARAMETERS:

start_point:	The start position of the cam profile in the **TABLE**
end_point:	The end position of the cam profile in the **TABLE**
table_multiplier:	The table values are multiplied by this value to generate the positions.
link_distance:	The distance the link axis must move to complete **CAMBOX** profile.
link_axis:	The axis to link to.

link_options:	Bit value options to customize how your **CAMBOX** operates		
	Bit 0	1	link commences exactly when registration event **MARK** occurs on link axis
	Bit 1	2	link commences at an absolute position on link axis (see link_pos for start position)
	Bit 2	4	**CAMBOX** repeats automatically and bi-directionally when this bit is set. (This mode can be cleared by setting bit 1 of the **REP_OPTION** axis parameter)
	Bit 3	8	**PATTERN** mode. Advanced use of **CAMBOX**: allows multiple scale values to be used
	Bit 5	32	Link is only active during a positive move on the link axis
	Bit 7	128	Forces the profile to start at a defined point in the link_dist (see offset_start for the position)
	Bit 8	256	link commences exactly when registration event **MARKB** occurs on link axis
	Bit 9	512	link commences exactly when registration event **R_MARK** occurs on link axis. (see link_pos for channel number)
link_pos:	link_option bit 1 - the absolute position on the link axis in user **UNITS** where the **CAMBOX** is to be start. link_option bit 9 – the registration channel to start the movement on		
offset_start:	The position defined on the link_dist where the profile will start		

The link_dist is in the user units of the link axis and should always be specified as a positive distance.

The link options for start (bits 0, 1, 8 and 9) may be combined with the link options for repeat (bits 2 and 5) and direction as well as offset_start (bit 7).

start_pos cannot be at or within one servo period's worth of movement of the **REP_DIST** position.

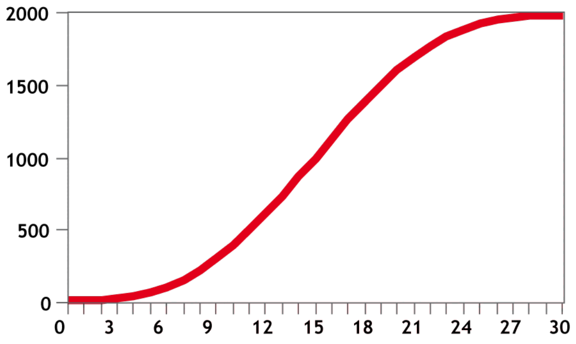
EXAMPLES:

EXAMPLE 1:

A subroutine can be used to generate a **SINE** shaped speed profile. This profile is used in the other examples.

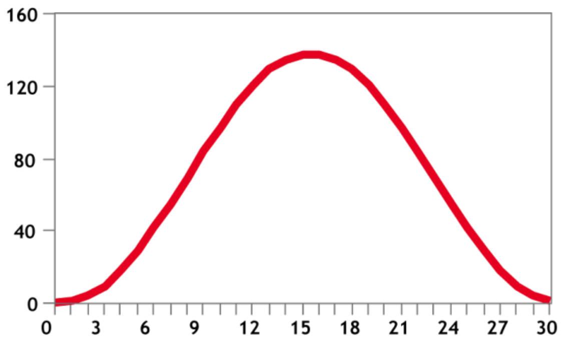
```
      ' p is loop counter
      ' num_p is number of points stored in tables pos 0..num_p
      ' scale is distance travelled scale factor
  profile_gen:
    num_p=30
```

```
        scale=2000
        FOR p=0 TO num_p
          TABLE(p,((-SIN(PI*2*p/num_p)/(PI*2))+p/num_p)*scale)
        NEXT p
        RETURN
```



This graph plots **TABLE** contents against table array position. This corresponds to motor **POSITION** against link **POSITION** when called using **CAMBOX**. The **SPEED** of the motor will correspond to the derivative of the position curve above:

Speed Curve

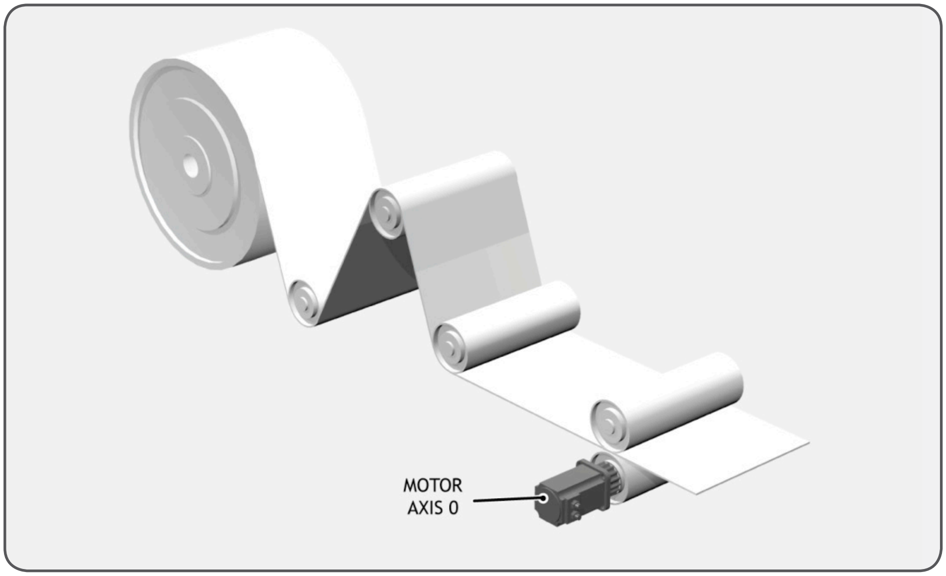


EXAMPLE 2:

A pair of rollers feed plastic film into a machine. The feed is synchronised to a master encoder and is activated when the master reaches a position held in the variable "start". This example uses the table points 0...30 generated in Example 1:

0	The start of the profile shape in the **TABLE**
30	The end of the profile shape in the **TABLE**
800	This scales the **TABLE** values. Each **CAMBOX** motion would therefore total 800*2000 encoder edges steps.
80	The distance on the product conveyor to link the motion to. The units for this parameter are the programmed distance units on the link axis.
15	This specifies the axis to link to.
2	This is the link option setting - Start at absolute position on the link axis.
variable "start"	The motion will execute when the position "start" is reached on axis 15.

```
start=1000
    FORWARD AXIS(1)
    WHILE IN(2)=OFF
      CAMBOX(0,30,800,80,15,2,start)
      WA(10)
      WAIT UNTIL MTYPE=0 OR IN(2)=ON
    WEND
    CANCEL
    CANCEL AXIS(1)
    WAIT IDLE
```



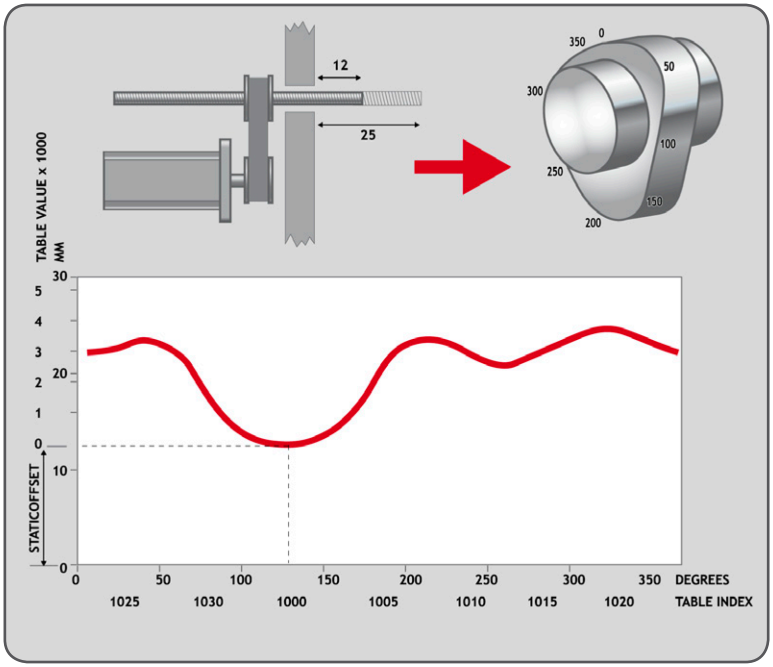
EXAMPLE 3:

A motor on Axis 0 is required to emulate a rotating mechanical CAM. The position is linked to motion on axis 3. The “shape” of the motion profile is held in **TABLE** values 1000..1035.

The table values represent the mechanical cam but are scaled to range from 0-4000

```
TABLE(1000,0,0,167,500,999,1665,2664,3330,3497,3497)
TABLE(1010,3164,2914,2830,2831,2997,3164,3596,3830,3996,3996)
TABLE(1020,3830,3497,3330,3164,3164,3164,3330,3467,3467,3164)
TABLE(1030,2831,1998,1166,666,333,0)

BASE(3)
MOVEABS(130)
WAIT IDLE
'start the continuously repeating cambox
CAMBOX(1000,1035,1,360,3,4) AXIS(0)
FORWARD             'start camshaft axis
WAIT UNTIL IN(2)=OFF
REP_OPTION = 2      'cancel repeating mode by setting bit 1
WAIT IDLE AXIS(0)   'waits for cam cycle to finish
CANCEL              'stop camshaft axis
WAIT IDLE
```

The firmware resets bit 1 of **REP_OPTION** after the repeating mode has been cancelled.



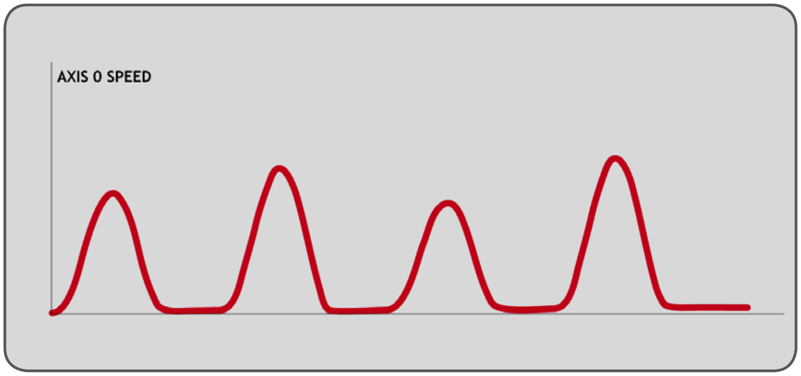
CAMBOX PATTERN MODE:

SYNTAX:

`CAMBOX(start_point, end_point, control_block_pointer, link_dist, link_axis, options)`

DESCRIPTION:

Setting bit 3 (value 8) of the link options parameter enables the **`CAMBOX`** pattern mode. This mode enables a sequence of scaled values to be cycled automatically. This is normally combined with the automatic repeat mode, so the link options parameter should be set to 12. This diagram shows a typical repeating pattern which can be automated with the **`CAMBOX`** pattern mode:



The start and end parameters specify the basic shape profile **ONLY**. The pattern sequence is specified in a separate section of the **TABLE** memory. There is a new **TABLE** block defined: The "Control Block". This block of seven **TABLE** values defines the pattern position, repeat controls etc. The block is fixed at 7 values long.

Therefore in this mode only there are 3 independently positioned **TABLE** blocks used to define the required motion:

SHAPE BLOCK	This is directly pointed to by the **CAMBOX** command as in any **CAMBOX**.
CONTROL BLOCK	This is pointed to by the Control Block pointer. It is of fixed length (7 table values). It is important to note that the control block is modified during the **CAMBOX** operation. It must therefore be re-initialised prior to each use.
PATTERN BLOCK	The start and end of this are pointed to by two of the **CONTROL BLOCK** values. The pattern sequence is a sequence of scale factors for the **SHAPE**.

Negative motion on link axis:
The axis the **CAMBOX** is linked to may be running in a positive or negative direction. In the case of a negative direction link the pattern will execute in reverse. In the case where a certain number of pattern repeats is specified with a negative direction link, the first control block will produce one repeat less than expected. This is because the **CAMBOX** loads a zero link position which immediately goes negative on the next servo cycle triggering a **REPEAT COUNT**. This effect only occurs when the **CAMBOX** is loaded, not on transitions from **CONTROL BLOCK** to **CONTROL BLOCK**. This effect can easily be compensated for either by increasing the required number of repeats, or setting the initial value of **REPEAT POSITION** to 1.

PARAMETERS:

start_point:	The start position of the shape block in the **TABLE**
end_point:	The end position of the shape block in the **TABLE**
control_block_pointer:	The position in the table of the 7 point control block

link_distance:	The distance the link axis must move to complete **CAMBOX** profile.
link_axis:	The axis to link to.
options:	As **CAMBOX**, bit 3 must be enabled

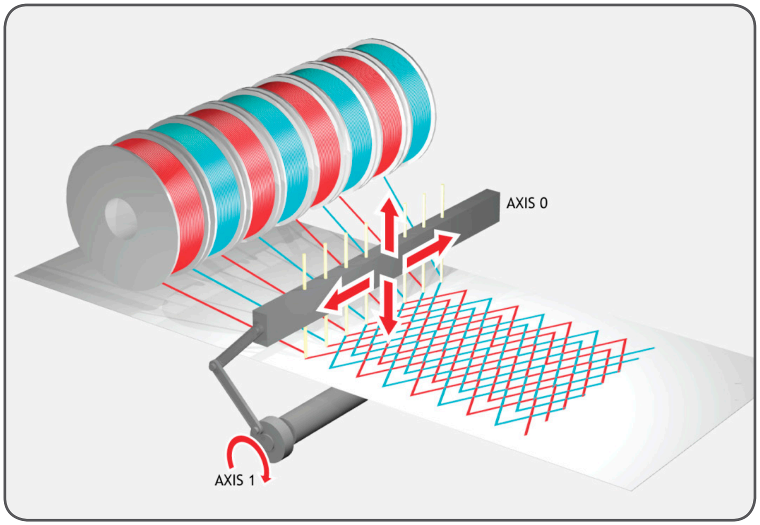
CONTROL BLOCK PARAMETERS

#	Name	Access	Description
0	**CURRENT POSITION**	R	The current position within the **TABLE** of the pattern sequence. This value should be initialised to the **START PATTERN** number.
1	**FORCE POSITION**	R/W	Normally this value is -1. If at the end of a **SHAPE** the user program has written a value into this **TABLE** position the pattern will continue at this position. The system software will then write -1 into this position. The value written should be inside the pattern such that the value: CB(2)<=CB(1)<=CB(3)
2	**START PATTERN**	R	The position in the **TABLE** of the first pattern value.
3	END **PATTERN**	R	The position in the **TABLE** of the final pattern value
4	**REPEAT POSITION**	R/W	The current pattern repeat number. Initialise this number to 0. The number will increment when the pattern repeats if the link axis motion is in a positive direction. The number will decrement when the pattern repeats if the link axis motion is in a negative direction. Note that the counter runs starting at zero: 0,1,2,3…
5	**REPEAT COUNT**	R/W	Required number of pattern repeats. If -1 the pattern repeats endlessly. The number should be positive. When the **ABSOLUTE** value of CB(4) reaches CB(5) the **CAMBOX** finishes if CB(6)=-1. The value can be set to 0 to terminate the **CAMBOX** at the end of the current pattern. See note below, next page, on **REPEAT COUNT** in the case of negative motion on the link axis.
6	**NEXT CONTROL BLOCK**	R/W	If set to -1 the pattern will finish when the required number of repeats are done. Alternatively a new control block pointer can be used to point to a further control block.

READ/**WRITE** values can be written to by the user program during the pattern **CAMBOX** execution.

EXAMPLE:

A quilt stitching machine runs a feed cycle which stiches a plain pattern before starting a patterned stitch. The plain pattern should run for 1000 cycles prior to running a pattern continuously until requested to stop at the end of the pattern. The cam profile controls the motion of the needle bar between moves and the pattern table controls the distance of the move to make the pattern.



The same shape is used for the initialisation cycles and the pattern. This shape is held in **TABLE** values 100..150

The running pattern sequence is held in **TABLE** values 1000..4999

The initialisation pattern is a single value held in **TABLE**(160)

The initialisation control block is held in **TABLE**(200)..**TABLE**(206)

The running control block is held in **TABLE**(300)..**TABLE**(306)

```
' Set up Initialisation control block:
TABLE(200,160,-1,160,160,0,1000,300)

' Set up running control block:
TABLE(300,1000,-1,1000,4999,0,-1,-1)

' Run whole lot with single CAMBOX:
' Third parameter is pointer to first control block

CAMBOX(100,150,200,5000,1,20)
WAIT UNTIL IN(7)=OFF

TABLE(305,0)  ' Set zero repeats: This will stop at end of pattern
```

SEE ALSO:

REP_OPTION

CAN

TYPE:
System Command

SYNTAX:
`CAN(slot, function[, parameters])`

DESCRIPTION:
This function allows the CAN communication channels to be controlled from the Trio **`BASIC`**. All *Motion Coordinator's* have a single built-in CAN channel which is normally used for digital and analogue I/O using Trio's I/O modules.

In addition to using the CAN command to control CAN channels, there are specific protocol functions into the firmware. These functions are dedicated software modules which interface to particular devices. The built-in CAN channel will automatically scan for Trio I/O modules if the system parameter **`CANIO_ADDRESS`** is set to its default value of 32.

Channel:	Channel Number:	Maximum Baudrate:
Built-in CAN	-1	1 Mhz

There are 16 message buffers in the controller

PARAMETERS:

slot:	**Set to -1 for the built in CAN port**	
function:	0	Read Register, do not use unless instructed by Trio or a Distributor.
	1	Write Register, do not use unless instructed by Trio or a Distributor.
	2	Initialise baud rate
	3	Check for message received
	4	Transmit OK
	5	Initialise message
	6	Read message
	7	Write message
	8	Read CANOpen Object
	9	Write CANOpen Object
	11	Initialise 29bit message
	20	CAN mode
	21	Enable CAN driver
	22	Reset CAN message buffer
	23	Specify CAN **VR** map
	24	Enable and configure a Sync telegram

FUNCTION = 2:

SYNTAX:

```
CAN(channel,2,baudrate)
```

DESCRIPTION:

Initialise the baud rate of the CANBus

PARAMETERS:

baudrate:	0	1MHz
	1	500kHz (default value)
	2	250kHz
	3	125kHz

FUNCTION = 3:

SYNTAX:
`value=CAN(channel, 3, message)`

DESCRIPTION:
Check to see if there is a new message in the message buffer

PARAMETERS:

message:	message buffer to check	
value:	`TRUE`	new message available
	`FALSE`	no new message

FUNCTION = 4:

SYNTAX:
`value=CAN(channel, 4, message)`

DESCRIPTION:
Checks that it is ok to transmit a message

PARAMETERS:

message:	message buffer to transmit	
value:	`TRUE`	OK to transmit
	`FALSE`	Network busy

FUNCTION = 5:

SYNTAX:

`CAN(channel#, 5, message, identifier, length, rw)`

DESCRIPTION:

Initialise a message by configuring its buffers size and if it is transmit or receive.

PARAMETERS:

message:	message buffer to initialise	
identifier:	the identifier which the message buffer appears on the CANBus	
length:	the size of the message buffer	
rw:	0	read buffer
	1	write buffer

FUNCTION = 6:

SYNTAX:

`CAN(channel, 6, message, variable)`

DESCRIPTION:

Read in the message from the specified buffer to a **VR** array.

The first **VR** holds the identifier. The subsequent values hold the data bytes from the CAN packet.

PARAMETERS:

message:	the message buffer to read in
variable:	the start position in the **VR** memory for the message to be written

FUNCTION = 7:

SYNTAX:

`CAN(channel, 7, message, byte0, byte1..)`

DESCRIPTION:

Write a message to a message buffer.

PARAMETERS:

message:	the message buffer to write the message in
byte0:	the first byte of the message
byte1:	the second byte of the message
…	

FUNCTION = 8:

SYNTAX:
```
CAN(channel, 8, transbuf, recbuf, object, subindex, variable)
```

DESCRIPTION:
Read a CANOpen object. The first **VR** holds the variable data type. The subsequent values hold the data bytes from the CAN packet.

PARAMETERS:

transbuf:	the message buffer used to transmit
recbuf:	the message buffer used to recieve
object:	the CANOpen object to read
subindex:	the sub index of the CANOpen object to read
variable:	the start position in the **VR** memory for the message to be written

FUNCTION = 9:

SYNTAX:
```
CAN(channel, 9, transbuf, recbuf, format, object, subindex, value,
{valuems})
```

DESCRIPTION:
Write a CANOpen object. This function automatically requests the send so you do not need to use function 4.

PARAMETERS:

transbuf:	the message buffer used to transmit

recbuf:	the message buffer used to recieve
format:	data size in bits 8, 16 or 32
object:	the CANOpen object to write to
subindex:	the sub index of the CANOpen object to write to
value:	the least significant 16 bits of the value to write
valuems:	the most significant 16 bit of the value to write

FUNCTION = 11:

SYNTAX:
`CAN(channel#, 11, message, identifierms, identifier, length, rw)`

DESCRIPTION:
Initialise a message by configuring its buffers size and if it is transmit or receive using 29 bit identifiers.

PARAMETERS:

message:	message buffer to initialise	
identifierms:	the most significant 13 bits of the identifier	
identifier:	the least significant 16 bits if the identifier	
length:	the size of the message buffer	
rw:	0	read buffer
	1	write buffer

FUNCTION = 20:

SYNTAX:
`CAN(channel, 20,mode)`

DESCRIPTION:
Sets the CAN mode, normally this is done using **`CANIO_ADDRESS`**

PARAMETERS:

Mode:	0	Disable all CAN operations
	1	CAN command mode
	2	**CANIO** mode (default)
	3	CANopenIO mode (**CANOPEN_OP_RATE** controls the cycle period, default = 5ms)

Unlike **CANIO_ADDRESS** this is **NOT** stored in flash EPROM

FUNCTION = 21:

SYNTAX:
```
CAN(channel, 21,enable)
```

DESCRIPTION:
Provides the ability to reset the CAN driver. Do not use unless instructed by Trio or a Distributor.

PARAMETERS:

Enable:	0	Disable
	1	Enable (default)

FUNCTION = 22:

SYNTAX:
```
CAN(channel, 22, message)
```

DESCRIPTION:
Reset a message buffer

PARAMETERS:

message:	the message buffer to reset

FUNCTION = 23:

SYNTAX:
```
CAN(channel, 23, [message, map, offset, length, order, variable,
direction [,data_type]])
```

DESCRIPTION:

Specify CAN **VR** map for use with CANOpenIO mode

If no parameters provided then current mappings are displayed

PARAMETERS:

message:	message buffer (0..15)
map:	MAP number (0..7)
offset:	CAN buffer byte offset (0..7)
length:	CAN buffer byte length (1..8)
order:	Endian Byte order (0=Little, 1=Big)
variable:	Index of variable in the controller
direction:	Direction (0=Receive, 1=Transmit)
data_type:	0 =inactive 1 = **VR** (default), 2 = Digital IO, 3 = Analogue IO

FUNCTION = 24:

SYNTAX:

```
CAN(channel, 24, enable, message, period)
```

DESCRIPTION:

Set up a Cyclic Sync Telegram for CANOpenIO mode. After **CANIO_ENABLE** is set to 1, the firmware will send the sync telegram at the specified period, synchronised with the internal servo cycle of the *Motion Coordinator*.

PARAMETERS:

enable:	1 = enable sync telegram, 0 = disable
message:	message buffer (0..15)
period:	Sync period in milliseconds

EXAMPLE:

```
      CAN(-1,5,14,128,0,1) ‘ Set buffer 14 for SYNC CobID=$80 (128)
      CAN(-1,24,1,14,4) ‘ sync telegram every 4 msec

      CAN(-1,7,15,1,0) ‘ Set the CanOpen slave modules to run state
      CANIO_ENABLE=1
```

SEE ALSO:

CANIO_ADDRESS, **CANOPEN_OP_RATE**

CANCEL

TYPE:

Axis Command

SYNTAX:

CANCEL([mode])

ALTERNATE FORMAT:

CA([mode])

DESCRIPTION:

Used to cancel current or buffered axis commands on an axis or an interpolating axis group. Velocity profiled moves, for example; **FORWARD**, **REVERSE**, **MOVE**, **MOVEABS**, **MOVECIRC**, **MHELICAL**, **MOVEMODIFY**, will be ramped down at the programmed **DECEL** or **FASTDEC** rate then terminated. Other move types will be terminated immediately.

CANCEL can be called manually, but also automatically by software limits, hardware limits and **MOTION_ERRORS**.

PARAMETERS:

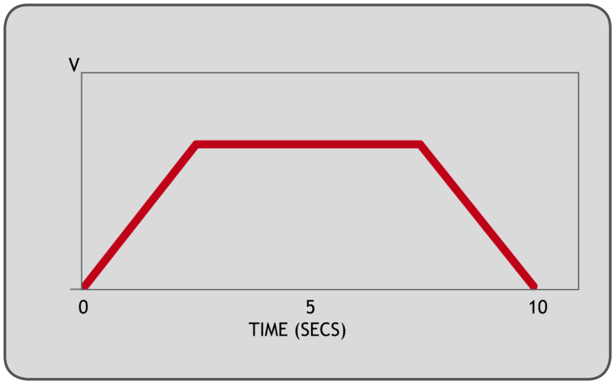
mode:	0	Cancels axis commands from the **MTYPE** buffer. Can be used without the parameter
	1	Cancels all buffered moves on the base axis (excluding the **PMOVE**)
	2	Cancels all active and buffered moves including the **PMOVE** if it is to be loaded on the **BASE** axis

CANCEL will only cancel the presently executing move. If further moves are buffered they will then be loaded and the axis will not stop.

EXAMPLES:

EXAMPLE 1:

Move the base axis forward at the programmed **SPEED**, wait for 10 seconds, then slow down and stop the axis at the programmed **DECEL** rate.



```
FORWARD
WA(10000)
CANCEL' stop movement after 10 seconds
```

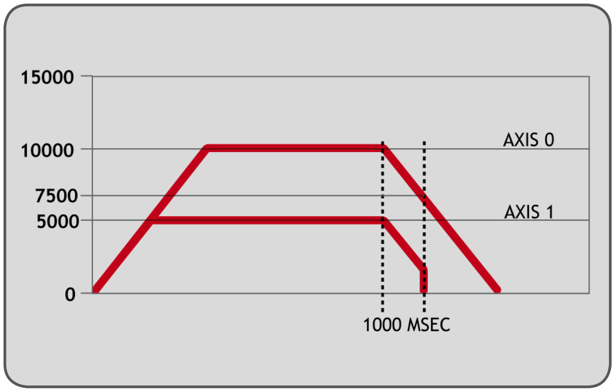
EXAMPLE 2:

A flying shear uses a sequence of MOVELINKs to make the base axis follow a reference encoder on axis 4. When the shear returns to the top position an input is triggered, this removes the buffered **MOVELINK** and replace with a decelerating **MOVELINK** to ramp down the slave (base) axis.

```
ref_axis = 4
REPEAT
  MOVELINK(100,100,0,0,ref_axis)
  WAIT LOADED    'make sure the NTYPE buffer is empty each time
UNTIL IN(5)=ON
CANCEL(1)        'cancel the movelink in the NTYPE buffer
MOVELINK(100,200,0,200,ref_axis) ' deceleration ramp
CANCEL          'cancel the main movelink, this starts the decel
```

EXAMPLE 3:

Two axes are connected with a ratio of 1:2. Axis 0 is cancelled after 1 second, then axis 1 is cancelled when the speed drops to a specified level. Following the first cancel axis 1 will decelerate at the **DECEL** rate. When axis 1's **CONNECT** is cancelled it will stop instantly.



```
    BASE(0)
    SPEED=10000
    FORWARD
    CONNECT(0.5,0) AXIS(1)
    WA(1000)
    CANCEL
    WAIT UNTIL VP_SPEED<=7500
    CANCEL AXIS(1)
```

SEE ALSO:

RAPIDSTOP, FASTDEC

CANIO_ADDRESS

TYPE:

System Parameter (**MC_CONFIG** / **FLASH**)

DESCRIPTION:

CANIO_ADDRESS is used to set the operating mode of the CANBus. You can select between Trio CAN, DeviceNet, CANOpen and a user configuration when implementing your own can protocol.

The value is held in flash EPROM in the controller and for most systems does not need to be set from the default value of 32.

If the value is not set to 32 then you cannot connect to Trio CAN I/O

VALUES:

32	Trio CAN I/O Master 64in/64out
33	DeviceNet
34...39	User range
40	CanOpen I/O Master 64in/64out
41	CanOpen I/O Master 128in/128out
42	CANOpen I/O Master custom mapping

CANIO_BASE

TYPE:
System Parameter (**MC_CONFIG**)

DESCRIPTION:
This parameter sets the start address of any CAN module I/O channels. Together with **MODULEIO_BASE**, DRIVEIO_BASEand **NODE_IO** the I/O allocation scheme can replace and expand the behaviour of **MODULE_IO_MODE**, however MODULE_IO_MODEtakes precedence if its value has been changed to 2 (**CANIO** followed by **MODULE** IO).

VALUE:

-1	No effect (**CANIO** should be disabled using **CANIO_ADDRESS**)
0	CAN I/O allocated automatically (default)
>= 8	CAN I/O is located at this IO point address, truncated to the nearest multiple of 8

EXAMPLE:
A system with MC464, a Panasonic module (slot 0) and a **CANIO** Module will have the following I/O assignment:

CANIO_BASE=0 + **DRIVEIO_BASE**=0 + **MODULEIO_BASE**=0

0-7	Built in inputs
8-15	Built in bi-directional I/O
16-23	Panasonic module inputs
24-39	**CANIO** bi-directional I/O

40-47	Panasonic drive inputs
48-1023	Virtual I/O

CANIO_BASE=100 + **DRIVEIO_BASE**=0 + **MODULEIO_BASE**=0

0-7	Built in inputs
8-15	Built in bi-directional I/O
16-23	Panasonic module inputs
24-31	Panasonic drive inputs
32-95	Virtual I/O
96-103	**CANIO** bi-directional I/O
104-1023	Virtual I/O

SEE ALSO:
MODULEIO_BASE, DRIVEIO_BASE, NODE_IO, MODULE_IO_MODE

CANIO_ENABLE

TYPE:
System Parameter

DESCRIPTION:
CANIO_ENABLE enables the Trio CAN I/O or CANOpen protocol.

When using the Trio I/O protocol it is set automatically by firmware. You have to set **CANIO_ENABLE**=ON manually after configuring CANOpen IO.

VALUE:

ON	Enable the CAN protocol (default when **CANIO_ADDRESS**=32)
OFF	Disable the CAN protocol (default when **CANIO_ADDRESS**<>32)

CANIO_MODE

TYPE:
System Parameter (**`MC_CONFIG`** / **`FLASH`**)

DESCRIPTION:
`CANIO_MODE` is used to set the operating mode of the Trio CAN I/O system. The MC4xx *Motion Coordinators* allow separate Input and Output modules to occupy overlapping addresses. This allows up to 32 Input and Output modules to be connected. Alternatively, the **`CANIO_MODE`** can be set to force the MC4xx *Motion Coordinator* to work in the same way as the MC2xx series, with only 16 digital modules of any type allowed.

The value is held in flash EPROM and can be set in the **`MC_CONFIG`** script.

VALUE:

0	MC4xx CAN IO addressing (default)
1	Compatibility mode CAN IO addressing

CANIO_STATUS

TYPE:
System Parameter

DESCRIPTION:
Returns the status of the Trio CAN I/O network. You can set bit 4 to reset the network.

VALUE:

Bit	Description	Value
0	Error from the I/O module 0,3,6 or 9	1
1	Error from the I/O module 1,4,7 or 10	2
2	Error from the I/O module 2,5,8 or 11	4
3	Error from the I/O module 12,13,14 or 15	8
4	Should be set to re-initialise the **`CANIO`** network	16
5	Is set when initialisation is complete	32
6	Error from Analogue module	64
7	Output error (0-3)	128

Bit	Description	Value
8	Output error (4-7)	256
9	Output error (8-11)	512
10	Output error (12-15)	1024
11	Input error (0-3)	2048
12	Input error (4-7)	4096
13	Input error (8-11)	8192
14	Input error (12-15)	16384

CANOPEN_OP_RATE

TYPE:
System Parameter

DESCRIPTION:
Used to adjust the transmission rate of CanOpen I/O PDO telegrams.

VALUE:
Default is 5msec. Adjustable in 1msec steps.

CHANGE_DIR_LAST

TYPE:
Axis Parameter (read only)

DESCRIPTION:
Returns the difference between the direction of the end of the previous loaded interpolated motion command and the start direction of the last loaded interpolated motion command. If there is no previous loaded command then **`END_DIR_LAST`** can be written to set an initial direction.

This parameter is only available when using **`SP`** motion commands such as **`MOVESP`**, **`MOVEABSSP`** etc.

VALUE:
Change in direction, in radians between 0 and PI. Value is always positive.

EXAMPLE:

```
    Perform a 90 degree move and print the change.
    >>MOVESP(0,100)
    >>MOVESP(100,0)
    >>PRINT CHANGE_DIR_LAST
    1.5708
    >>
```

SEE ALSO:

END_DIR_LAST, START_DIR_LAST

CHANNEL_READ

TYPE:

System Command

SYNTAX:

x = CHANNEL_READ(channel, storage_buffer[, delimiter_buffer[, escape_ character[, crc]]])

DESCRIPTION:

CHANNEL_READ will read bytes from the channel and store them into the storage buffer.

If the storage buffer is in **VR** then the first value specifies why the **CHANNEL_READ** stopped: 0 for end of file, 1 for the first delimiter character, 2 for the second delimiter character, etc, and the command returns the number of characters read. The string is null terminated so the **VRSTRING** command can be used to view the buffer as a string.

If the storage buffer is a named string variable then the command returns why the **CHANNEL_READ** stopped. The number of characters read can be obtained using the LEN command on the named string variable.

CHANNEL_READ will stop when it has read size bytes, the channel is empty, or the character read from the channel is specified in the delimiter buffer.

If the escape character received then the next character is not interpreted. This allows delimiter characters to be received without stopping the **CHANNEL_READ**.

The calculated CRC will be stored in the **VR**(crc).

PARAMETERS:

channel	Communication or file channel.
storage_buffer	1 named string variable, or 2 numerical expressions that specify the **VR** base and length.

delimiter_buffer	1 string expression, or 2 numerical expressions that specify the **VR** base and length.
escape_character	When this character is received the following character is not interpreted.
crc	Position in the **VR** data where the CRC will be stored.

EXAMPLE 1:

Read numbers from a file: one number per line, using **VR** storage and delimiter buffers.

```
    ‘ create a temp file in RAM that contains the numbers 1 to 10,
    ‘ one line per number
    OPEN #40 AS “ram:test” FOR OUTPUT(1)
    FOR i=1 TO 10
        PRINT #40,i
    NEXT i
    CLOSE #40

    ‘ set the delimiters
    VR(10)=13’carriage return
    VR(11)=10’line feed

    ‘ test vr functionality
    OPEN #40 AS “ram:test” FOR INPUT
    PRINT “-------------------- START VR ---------------------”
    REPEAT
        ‘ read channel 40.
        ‘ VR(100) has the end status
        ‘ VR(101)-VR(199) hold the data
        ‘ VR(10)-VR(11) hold the delimiters
        c=CHANNEL_READ(40,100,100,10,2)

        ‘ if we have characters then print them
        IF (c > 0) THEN
            PRINT c[0], VR(100)[0], VRSTRING(101)
        ENDIF
        IF VR(100) = 1 THEN
            PRINT “--- CARRIAGE RETURN ----”
        ELSEIF VR(100)=2 THEN
            PRINT “--- LINE FEED ----”
        ENDIF

    UNTIL NOT KEY#40
    PRINT “-------------------- STOP VR ---------------------”
    CLOSE #40
```

EXAMPLE 2:

Read numbers from a file: one number per line, using string storage and delimiter buffers.

```
    ‘ create a temp file in RAM that contains the numbers 1 to 10,
    ‘ one line per number
    OPEN #40 AS “ram:test” FOR OUTPUT(1)
```

```
FOR i=1 TO 10
    PRINT #40,i
NEXT i
CLOSE #40

‘ declare the buffers
DIM b AS STRING(100)
DIM d AS STRING(2)

‘ set the delimiters
d=CHR(13)+CHR(10)

‘ test string functionality
OPEN #40 AS “ram:test” FOR INPUT
PRINT “-------------------- START STRING ---------------------”
REPEAT
    ‘ read channel 40.
    s=CHANNEL_READ(40,b,d)
    c=LEN(b)

    ‘ if we have characters then print them
    IF (c > 0) THEN
        PRINT c[0], s[0], b
    ENDIF
    IF s = 1 THEN
        PRINT “--- CARRIAGE RETURN ----”
    ELSEIF s=2 THEN
        PRINT “--- LINE FEED ----”
    ENDIF
UNTIL NOT KEY#40
PRINT “-------------------- STOP STRING ---------------------”
CLOSE #40
```

EXAMPLE 3:

Read numbers from a file: one number per line, using string storage buffer and **VR** delimiter buffer.

```
‘ create a temp file in RAM that contains the numbers 1 to 10,
‘ one line per number
OPEN #40 AS “ram:test” FOR OUTPUT(1)
FOR i=1 TO 10
    PRINT #40,i
NEXT i
CLOSE #40

‘ declare the buffers
DIM b AS STRING(100)

‘ set the delimiters
VR(10)=13’carriage return
VR(11)=10’line feed
```

```
    ` test string functionality
    OPEN #40 AS "ram:test" FOR INPUT
    PRINT "-------------------- START STRING ---------------------"
    REPEAT
        ` read channel 40.
        s=CHANNEL_READ(40,b,10,2)
        c=LEN(b)

        ` if we have characters then print them
        IF (c > 0) THEN
            PRINT c[0], s[0], b
        ENDIF
        IF s = 1 THEN
            PRINT "--- CARRIAGE RETURN ----"
        ELSEIF s=2 THEN
            PRINT "--- LINE FEED ----"
        ENDIF
    UNTIL NOT KEY#40
    PRINT "-------------------- STOP STRING ---------------------"
    CLOSE #40
```

CHECKSUM

TYPE:
Reserved Keyword

CHR

TYPE:
String Function

SYNTAX:
`value = CHR(number)`

DESCRIPTION:
CHR returns the **`ASCII`** character as a **`STRING`** which is referred to by the number, this can be assigned to a **`STRING`** variable or be PRINTed.

Parameters:

number:	Any valid numerical value for an **`ASCII`** character

value:	A **STRING** containing the character

EXAMPLES:

EXAMPLE 1:
Print the character A on the command line

```
>>PRINT CHR(65)
A
>>
```

EXAMPLE 2:
Print a line of text terminating only with a carriage return

```
PRINT#5, “abcdefghijk”; CHR(13)
```

EXAMPLE 3:
Append a character from the serial port to a **STRING** variable

```
DIM value AS STRING
WHILE KEY#5
  GET#5, char
  value = value + CHR(char)
WEND
```

SEE ALSO:
PRINT, STRING

CLEAR

TYPE:
System Command

DESCRIPTION:
Sets all global (numbered) variables and **VR** values to 0 and sets local variables on the process on which command is run to 0.

Trio BASIC does not clear the global variables automatically following a **RUN** command. This allows the global variables, which are all battery-backed to be used to hold information between program runs. Named local variables are always cleared prior to program running. If used in a program **CLEAR** sets local variables in this program only to zero as well as setting the global variables to zero.

CLEAR does not alter the program in memory.

EXAMPLE:

```
    Setting and clearing VR values.
    VR(0)=44
    VR(10)=12.3456
    VR(100)=2
    PRINT VR(0),VR(10),VR(100)
    CLEAR
    PRINT VR(0),VR(10),VR(100)
```

On execution this would give an output such as:

```
44.0000  12.345  62.0000
0.0000   0.0000  0.0000
```

CLEAR_BIT

TYPE:

Logical and Bitwise Command

SYNTAX:

`CLEAR_BIT(bit, variable)`

DESCRIPTION:

`CLEAR_BIT` can be used to clear the value of a single bit within a `VR`() variable.

PARAMETERS:

bit:	The bit number to clear, valid range is 0 to 52
variable:	The `VR` on which to operate

EXAMPLE:

Set bit 6 in `VR` 23 to zero.

```
    CLEAR_BIT(6,23)
```

SEE ALSO

`READ_BIT, SET_BIT`

CLEAR_PARAMS

TYPE:
System Command (command line only)

DESCRIPTION:
Resets all flash parameters to the default value. This command must only be used on the command line.

You must cycle power after issuing this command to ensure that all parameters take effect.

This will reset the **IP** address to the default value and so you may not be able to connect after cycling power.

You should use the **MC_CONFIG** file to set all **FLASH**/ **MC_CONFIG** parameters so that they are saved as part of the project.

CLOSE

TYPE:
System command

SYNTAX:
CLOSE channel

DESCRIPTION:
CLOSE will close the file on the specified channel.

PARAMETERS:

Channel	The TrioBASIC I/O channel to be associated with the file. It is in the range 40 to 44.

SEE ALSO:
OPEN

CLOSE_WIN

TYPE:
Axis Parameter

ALTERNATE FORMAT:
`CW`

DESCRIPTION:
By writing to this parameter the end of the window in which a registration mark is expected can be defined.

VALUE:
Position of the end of the position window in user units.

EXAMPLE:
Set a position window between 10 and 30

```
    OPEN_WIN = 10
    CLOSE_WIN = 30
```

SEE ALSO:
`OPEN_WIN, REGIST`

CLUTCH_RATE

TYPE:
Axis Parameter

DESCRIPTION:
This affects operation of **`CONNECT`** by changing the connection ratio at the specified rate/second.

Default **`CLUTCH_RATE`** is set very high to ensure compatibility with earlier versions.

VALUE:
Change in connection ratio per second (default 1000000)

EXAMPLE:
The connection ratio will be changed from 0 to 6 when an input is set. It is required to take 2 second to accelerate the linked axis so the ratio must change at 3 per second.

```
    CLUTCH_RATE = 3
```

```
CONNECT(0,0)
WAIT UNTIL IN(1)=ON
CONNECT(6,0)
```

CO_READ

TYPE:
System Command

SYNTAX:
CO_READ(slot, address, index, subindex ,type [,vr_number])

DESCRIPTION:
This function gets a CANopen-over-EtherCAT object from the remote drive or IO device. The Object's index and sub-index are used to request a value and that value is either placed in the **VR** or is displayed in the *Motion* Perfect terminal if the **VR** number is set to -1.

Refer to the remote device's manual for a list of available objects. If the object value is returned successfully, the command returns **TRUE**. (-1) Otherwise, in the case of an error while requesting the value, the command returns **FALSE**.

PARAMETERS:

slot:	Slot number of the EtherCAT module.	
address:	Node address of the remote device on the network	
index:	CANopen Object index	
subindex:	CANopen Object sub-index	
Type:	1	Boolean
	2	Integer 8
	3	Integer 16
	4	Integer 32
	5	Unsigned 8
	6	Unsigned 16
	7	Unsigned 32
	9	Visible String (to terminal only)

vr_number:	VR number between 0 and max **VR** where the result will be stored. (-1 means the value will be printed to the terminal)

EXAMPLES:

EXAMPLE 1:
Read the remote drive mode of operation and display to the terminal

```
>>CO_READ(0, 1, $6061, 0, 2, -1)
8
>>
```

EXAMPLE 2:
Get the remote drive interpolation time, objects $60C2 sub-index 1 and sub-index 2, and place in **VR**(200) and **VR**(201).

```
 'read object $60C2:01 unsigned 8
CO_READ(0, 5, $60C2, 1, 5, 200)
 'read object $60C2:02 signed 8
CO_READ(0, 5, $60C2, 2, 2, 201)
PRINT "Drive at node 5: "; VR(200)[0];"x 10^";VR(201)[0]
```

CO_READ_AXIS

TYPE:
System Command

SYNTAX:
CO_READ_AXIS(axis_number, index, subindex ,type [,vr_number])

DESCRIPTION:
This function gets a CANopen-over-EtherCAT object from the remote drive or IO device. The Object's index and sub-index are used to request a value and that value is either placed in the **VR** or is displayed in the *Motion* Perfect terminal if the **VR** number is set to -1.

Refer to the remote device's manual for a list of available objects. If the object value is returned successfully, the command returns **TRUE**. (-1) Otherwise, in the case of an error while requesting the value, the command returns **FALSE**.

PARAMETERS:

Axis_number:	Axis number of the EtherCAT drive.
index:	CANopen Object index

subindex:	CANopen Object sub-index	
Type:	1	Boolean
	2	Integer 8
	3	Integer 16
	4	Integer 32
	5	Unsigned 8
	6	Unsigned 16
	7	Unsigned 32
	9	Visible String (to terminal only)
vr_number:	VR number between 0 and max **VR** where the result will be stored. (-1 means the value will be printed to the terminal)	

EXAMPLES:

EXAMPLE 1:

Print the value for object 0x6064 sub-index 00, position actual value. This is a 32 bit long word and so has the CANopen type 4.

```
>>CO_READ_AXIS(3, $6064, 0, 4, -1)
5472
>>
```

EXAMPLE 2:

Get the proportional gain and velocity feedforward gain from the remote drive, and place in **VR**(200) and **VR**(201). Perform a check to make sure the object is supported by the drive.

```
IF CO_READ_AXIS(2, $60FB, 1, 6, 200) = FALSE THEN
  PRINT "Error reading Object $60FB:01"
ELSE
  PRINT "Drive P Gain = ";VR(200)[0]
ENDIF
IF CO_READ_AXIS(2, $60FB, 2, 6, 201) = FALSE THEN
  PRINT "Error reading Object $60FB:02"
ELSE
  PRINT "Drive VFF Gain = ";VR(201)[0]
ENDIF
```

CO_WRITE

TYPE:
System Command

SYNTAX:
`CO_WRITE(slot, address, index, subindex ,type, vr_number [,value])`

DESCRIPTION:
This function sets a CANopen-over-EtherCAT object in the remote drive or IO device. The Object's index and sub-index are used to write a value to that object. The value can come from a **VR** or is put into the command directly if the **VR** number is set to -1.

Refer to the remote device's manual for a list of available objects. If the object value is set successfully, the command returns **TRUE**. (-1) Otherwise, in the case of an error while writing the value, the command returns **FALSE**.

PARAMETERS:

slot:	Slot number of the EtherCAT module.	
address:	Node address of the remote device on the network	
index:	CANopen Object index	
subindex:	CANopen Object sub-index	
Type:	1	Boolean
	2	Integer 8
	3	Integer 16
	4	Integer 32
	5	Unsigned 8
	6	Unsigned 16
	7	Unsigned 32
	9	Visible String (N/A as this is read only)
vr_number:	VR number between 0 and max **VR** where the result will be stored. (-1 if the next parameter contains the value to be written)	
value:	Optional data value for direct setting of the object	

EXAMPLES:

EXAMPLE 1:

Set the remote drive at EtherCAT address 3 to homing mode.

```
>>CO_WRITE(0, 3, $6060, 0, 2, -1, 6)
>>
```

EXAMPLE 2:

Set the remote drive proportional gain and velocity feed forward gain to the values placed in **VR**(21) and **VR**(22).

```
VR(21) = 2500
VR(22) = 1000
' both objects are unsigned 16 bit (data type 6)
CO_WRITE(0, 1, $60fb, 1, 6, 21)
CO_WRITE(0, 1, $60fb, 2, 6, 22)
```

Always refer to the manufacturer’s user manual before writing to a CANopen object over EtherCAT.

CO_WRITE_AXIS

TYPE:

System Command

SYNTAX:

`CO_WRITE_AXIS(axis_number, index, subindex, type, vr_number [,value])`

DESCRIPTION:

This function sets a CANopen-over-EtherCAT object in the remote drive or IO device. The Object’s index and sub-index are used to write a value to that object. The value can come from a **VR** or is put into the command directly if the **VR** number is set to -1.

Refer to the remote device’s manual for a list of available objects. If the object value is set successfully, the command returns **TRUE**. (-1) Otherwise, in the case of an error while writing the value, the command returns **FALSE**.

PARAMETERS:

Axis_number:	Axis number of the EtherCAT drive.
index:	CANopen Object index

subindex:	CANopen Object sub-index	
Type:	1	Boolean
	2	Integer 8
	3	Integer 16
	4	Integer 32
	5	Unsigned 8
	6	Unsigned 16
	7	Unsigned 32
	9	Visible String (to terminal only)
vr_number:	VR number between 0 and max **VR** where the result will be stored. (-1 if the next parameter contains the value to be written)	
value:	Optional data value for direct setting of the object	

EXAMPLES:

EXAMPLE 1:

Write a value of 1 to a manufacturer specific object on servo drive at MC464 axis 3. CoE object 0x2802 sub-index 0x00, type 2 (8 bit integer). Get the **TRUE**/**FALSE** success indication and print it to the terminal.

```
>>?CO_WRITE_AXIS(3, $2802, 0, 2, -1, 1)
>>-1.0000
>>
```

EXAMPLE 2:

Write a position controller velocity feedforward gain value to the servo drive at MC464 axis 12. CoE object 0x60FB sub-index 0x02, type 6 (unsigned 16 bit integer).

```
VR(2010)=1000
' write the value from VR(2010)
error_flag = CO_WRITE_AXIS(12, $60fb, 2, 6, 2010)

IF error_flag = FALSE THEN
  PRINT "Error writing CANopen Object to Drive"
ENDIF
```

Always refer to the manufacturer's user manual before writing to a CANopen object over EtherCAT.

: Colon

TYPE:
Special Character

DESCRIPTION:
The colon character is used as a label terminator and as a command separator.

LABEL TERMINATOR

SYNTAX:
`label:`

DESCRIPTION:
The colon character is used to terminate labels used as destinations for **GOTO** and **GOSUB** commands.

Labels can also be used to aid readability of code.

PARAMETERS:

Label	may be character strings of any length but only the first 32 characters are significant. Labels must be the first item on a line and should have no leading spaces.

EXAMPLE:
Use an **ON...GOTO** structure to assign a value into **VR** 10 depending on a local variable ‘attempts’.

```
ON attempts GOTO label1, label2, label3
GOTO continue

label1:
VR(10)=1
GOTO continue

Label2:
VR(10)=5
GOTO continue

Label3:
VR(10)=2
GOTO continue

continue:
```

COMMAND SEPERATOR

SYNTAX:

```
statement: statement
```

DESCRIPTION:

The colon is also used to separate TrioBASIC statements on a multi-statement line.

PARAMETERS:

Statement: any valid TrioBASIC statement. The colon separator must not be used after a **THEN** command in a multi-line **IF**..**THEN** construct.

If a multi-statement line contains a **GOTO** the remaining statements will not be executed. Similarly with **GOSUB** because subroutine calls return to the following line.

EXAMPLES:

EXAMPLE 1:

Use of **GOTO** in the line means that any command following it will never be executed. This can be used as a debugging technique but usually happens due to a programming error.

```
    PRINT "Hello":GOTO Routine:PRINT "Goodbye"
```

"Goodbye" will not be printed.

EXAMPLE 2:

Set the speed, a position in the table and execute a move all in one line.

```
    SPEED=100:TABLE(10,123):MOVE(TABLE(10)
```

‘ Comment

TYPE:

Special Character

SYNTAX:

‘ text

DESCRIPTION:

A single ‘ is used to mark the start of a comment. A comment is a piece of text that is not compiled and just used to give the programmer information. It can be used at the start of a line or after a piece of code.

PARAMETERS:

text	Any notes that you wish to add to your program

EXAMPLE:
Using comments at the start of the program and in line to help document a program

```
     'Motion program version 1.35
    MOVE(100) 'Move to the start position
```

COMMSERROR

TYPE:
Reserved Keyword

COMMSPOSITION

TYPE:
Slot Parameter

DESCRIPTION:
Returns if the expansion module is on the top or the bottom bus.

VALUE:

-1	built in controller
1	module is on the top bus
0	module is on the bottom bus or no module fitted

COMMSTYPE

TYPE:
Slot Parameter (read only)

DESCRIPTION:
This parameter returns the type of communications daughter board in a controller slot.

VALUE:

Value	Communication type
0	Empty slot
32	SERCOS
37	Panasonic module
39	Sync encoder port
40	FlexAxis 4
41	FlexAxis 8
42	Ethercat module
43	SLM module
44	FlexAxis 8 SSI
62	Anybus module empty/ unrecognised
63	Anybus RS232
64	Anybus RS422
65	Anybus USB
66	Anybus Ethernet
67	Anybus Bluetooth
68	Anybus Zigbee
69	Anybus wireless LAN
70	Anybus RS485
71	Anybus Profibus
72	Anybus CC-Link
73	Anybus DeviceNet
74	Anybus Profinet 1 port
75	Anybus Profinet 2 port

EXAMPLE:

Check that the correct Anybus module is fitted before starting initialisation.

```
    IF COMMSTYPE SLOT(3) = 71
```

```
      GOSUB initialise_profibus
    ELSE
      PRINT#5, "No Profibus compact com module detected"
    ENDIF
```

COMPILE

TYPE:
System Command

DESCRIPTION:
Forces compilation of the currently selected program. Program compilation is performed automatically by the system software prior to program RUN or when another program is SELECTed. This command is not therefore normally required.

SEE ALSO:
`SELECT, COMPILE_ALL`

COMPILE_ALL

TYPE:
System Command

DESCRIPTION:
Forces compilation of all programs. Program compilation is performed automatically by the system software prior to program RUN or when another program is SELECTed. This command is not therefore normally required.

SEE ALSO:
`SELECT, COMPILE`

COMPILE_MODE

TYPE:
Startup Parameter (`MC_CONFIG`)

DESCRIPTION:
`COMPILE_MODE` controls whether or not all used variables have to be defined within a DIM statement as a

prerequisite before use or not.

The default setting (0) is the traditional compile mode where variables can be used without any need for declaration. However, by changing this parameter to 1, either within **MC_CONFIG** or at any time after startup, means that all new program compilations will require variables to be declared using DIM.

VALUE:

0	Local variables do not require explicit declaration (default)
1	Local variables require explicit declaration using DIM

EXAMPLES:

EXAMPLE 1:

COMPILE_MODE = 0 'No enforced variable declarations

EXAMPLE 2:

COMPILE_MODE = 1 'Force variable declarations via DIM

SEE ALSO:

DIM, COMPILE and COMPILE_ALL

CONNECT

TYPE:

Axis Command

SYNTAX:

`CONNECT(ratio, driving_axis)`

ALTERNATE FORMAT:

`CO(...)`

DESCRIPTION:

Links the demand position of the base axis to the measured movements of the driving axes to produce an electronic gearbox.

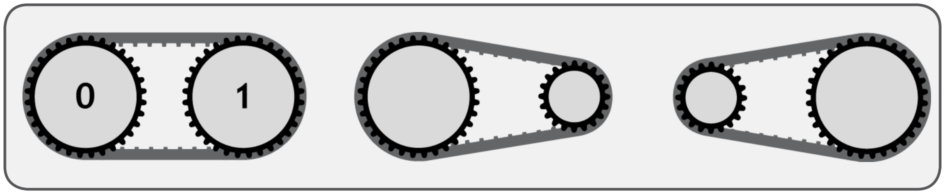
The ratio can be changed at any time by issuing another **CONNECT** command which will automatically update the ratio at **CLUTCH_RATE** without the previous **CONNECT** being cancelled. The command can be cancelled with a **CANCEL** or **RAPIDSTOP** command

You can prevent **CONNECT** from being canceled when a hardware or software limit is reached by setting the bit in **AXIS_MODE**. When this bit is set the ratio is temporarily set to zero while the limit is active so the axis will slow to a stop at the programmed **CLUTCH_RATE**.

PARAMETERS:

ratio:	This parameter holds the number of edges the base axis is required to move per increment of the driving axis. The ratio value can be either positive or negative. The ratio is always specified as an encoder edge ratio.
driving_axis:	This parameter specifies the axis to link to.

As **CONNECT** uses encoder data it is not affected by *UNITS*, if you need to change the scale of your encoder feedback you should use *ENCODER_RATIO*



To achieve an exact connection of fractional ratio's of values such as 1024/3072. The **MOVELINK** command can be used with the continuous repeat link option set to **ON**.

EXAMPLES:

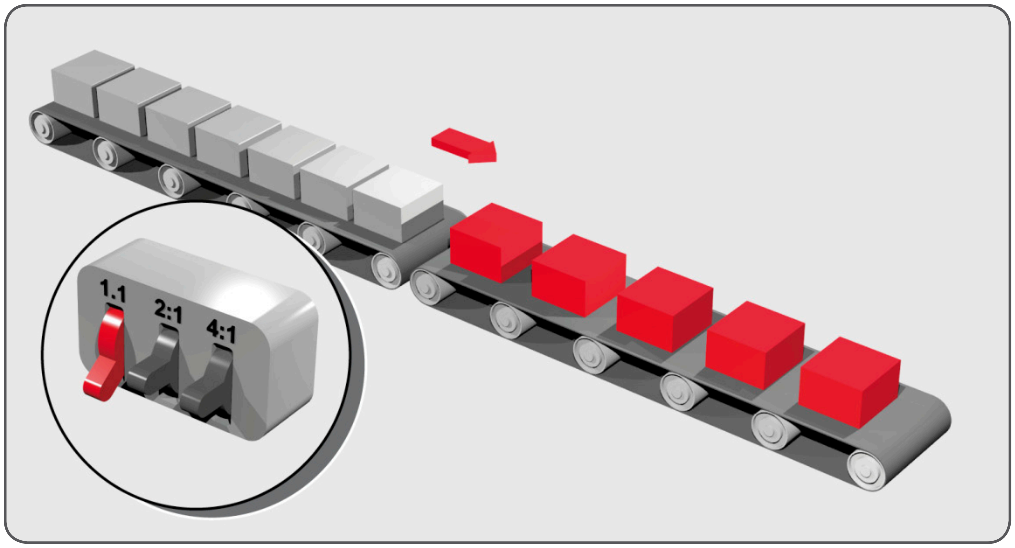
EXAMPLE 1:

In a press feed a roller is required to rotate at a speed one quarter of the measured rate from an encoder mounted on the incoming conveyor. The roller is wired to the master axis 0. The reference encoder is connected to axis 1.

```
BASE(0)
SERVO=ON
CONNECT(0.25,1)
```

EXAMPLE 2:

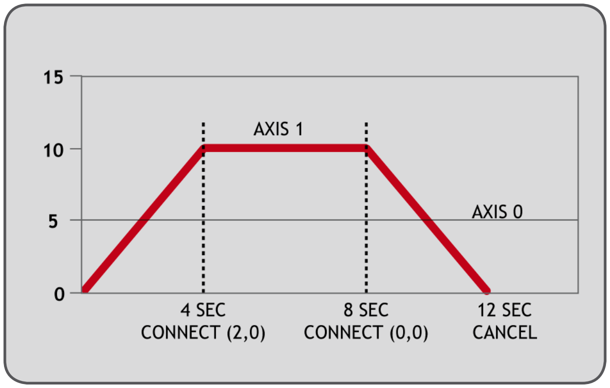
A machine has an automatic feed on axis 1 which must move at a set ratio to axis 0. This ratio is selected using inputs 0-2 to select a particular "gear", this ratio can be updated every 100msec. Combinations of inputs will select intermediate gear ratios. For example 1 ON and 2 ON gives a ratio of 6:1.



```
BASE(1)
FORWARD AXIS(0)
WHILE IN(3)=ON
  WA(100)
  gear = IN(0,2)
  CONNECT(gear,0)
WEND
RAPIDSTOP        'cancel the FORWARD and the CONNECT
```

EXAMPLE 3:

Axis 0 is required to run a continuous forward, axis 1 must connect to this but without the step change in speed that would be caused by simply calling the **CONNECT**. **CLUTCH_RATE** is used along with an initial and final connect ratio of zero to get the required motion.



```
FORWARD AXIS(0)
BASE(1)
CONNECT(0,0)      `set intitial ratio to zero
CLUTCH_RATE=0.5   `set clutch rate
CONNECT(2,0)      `apply the required connect ratio
WA(8000)
CONNECT(0,0)      `apply zero ratio to disconnect
WA(4000)          `wait for deceleration to complete
CANCEL            `cancel connect
```

SEE ALSO:

`AXIS_MODE, CLUTCH_RATE, ENCODER_RATIO`

CONNPATH

TYPE:

Axis Command

SYNTAX:

`CONNPATH(ratio , driving_axis)`

DESCRIPTION:

Enables you to link to the path of an interpolated movement by linking the demand position of the base axis, to the interpolated path distance of the driving axis.

The ratio can be changed at any time by issuing another **`CONNPATH`** command which will automatically update the ratio at **`CLUTCH_RATE`** without the previous **`CONNPATH`** being cancelled. The command can be cancelled with a **`CANCEL`** or **`RAPIDSTOP`** command.

As **CONNPATH** uses encoder data it is not affected by **UNITS**, if you need to change the scale of your encoder feedback you should use **ENCODER_RATIO**

PARAMETERS:

ratio:	This is the ratio between the interpolated distance moved on the driving axis to the distance moved on the base axis.
driving_axis:	This parameter specifies the axis to link to.

EXAMPLES:

EXAMPLE 1:

A glue laying robot uses a screw feed for the adhesive, this needs to turn a quarter of a revolution for every unit of distance moved.

```
BASE(0)
SERVO=ON
CONNPATH (0.25,1)
```

EXAMPLE 2:

It is required to move 156mm on axis 0 through an interpolated path distance of 100mm on axes 1,2 and 3. This is achieved by using virtual axis 4 as the path distance of the interpolated group and applying a **MOVELINK** from axis 0 to it. **SPEED** is initially set to zero so that the **MOVE** and **MOVELINK** start at the same time.

```
CONNPATH(1,1)AXIS(4)
a=100
b=100
c=100

BASE(1,2,3)
SPEED=0
MERGE=ON

MOVE(a,b,c)
WA(1)
MOVELINK(156,REMAIN AXIS(1),0,0,4)AXIS(0)
SPEED=10
```

SEE ALSO:

CLUTCH_RATE, ENCODER_RATIO

CONSTANT

TYPE:

System Command

SYNTAX:

`CONSTANT ["name"[, value]]`

DESCRIPTION:

Up to 1024 **CONSTANTS** can be declared in the controller, these are then available to all programs. They should be declared on startup and for fast startup the program declaring CONSTANTs should also be the **ONLY** process running at power-up.

Once a **CONSTANT** has been assigned it cannot be changed, even if you change the program that assigns it.

While developing you may wish to clear or change a **CONSTANT**. You can clear a single **CONSTANT** by using the first parameter alone. All **CONSTANTs** can be cleared by issuing **CONSTANT**. You can view all **CONSTANTS** using **LIST_GLOBAL**.

PARAMETERS:

name:	Any user-defined name containing lower case alpha, numerical or underscore (_) characters.
value:	The value assigned to the name.

EXAMPLES:

EXAMPLE 1:

Declare 2 CONSTANTs and use them within the program

```
CONSTANT "nak",$15
CONSTANT "start_button",5
IF IN(start_button)=ON THEN OP(led1,ON)
IF key_char=nak THEN GOSUB no_ack_received
```

EXAMPLE 2:

Use the command line to clear a defined constant

```
>>CONSTANT "NAK"
>>
```

EXAMPLE 3:

Use the command line to clear all defined constants

```
    >>CONSTANT
    >>
```

SEE ALSO:
GLOBAL, LIST_GLOBAL

CONTROL

TYPE:
System Parameter (Read Only)

DESCRIPTION:
The Control parameter returns the ID number of the *Motion Coordinator* in the system:

VALUE:

Value	Controller
400	MCSimulator
402	MC403Z
403	MC403
404	Euro404
405	MC405
408	Euro408
464	MC464

When the *Motion Coordinator* is **LOCKED**, 1000 is added to the above numbers. For example a locked MC464 will return 1464.

EXAMPLES:

EXAMPLE 1:
Checking the control value of a locked controller on the command line:

```
    >>PRINT CONTROL
    1464
    >>
```

EXAMPLE 2:

Checking the controller type in a program, if it fails then stop the programs. :

```
    IF CONTROL <> 464 THEN
      PRINT#terminal, “This program was designed to run a MC464”
      HALT
    ENDIF
```

COORDINATOR_DATA

TYPE:

Reserved Keyword

COPY

TYPE:

System Command (command line only)

SYNTAX:

`COPY “program” “newprogram”`

DESCRIPTION:

Used to make a copy of an existing program in memory under a new name.

PARAMETERS:

program:	the name of the program to be copied
newprogram:	the name of the copy

EXAMPLE:

Make a backup of a program named motion

```
    >>COPY “MOTION”  “MOTION_BACK”
    Compiling MOTION
    Linking MOTION
    Pass=4
    OK
    >>
```

CORNER_MODE

TYPE:
Axis Parameter

DESCRIPTION:
Allows the program to control the cornering action.

Automatic corner speed control enables system to reduce the speed depending on **DECEL_ANGLE** and **STOP_ANGLE**

The **CORNER_STATE** machine allows interaction with a TrioBASIC program and the loading of buffered moves depending on **RAISE_ANGLE**

Automatic radius speed control enables the system to reduce the speed depending on **FULL_SP_RADIUS**.

You can enable any combination of the speed control bits.

VALUE:
16bit value, each bit represents a different corner mode.

Bit	Description	Value
0	Reserved	1
1	Automatic corner speed control	2
2	Enable the **CORNER_STATE** machine	4
3	Automatic radius speed control	8

EXAMPLE:
Enable the corner state machine and automatic corner speed control.

```
    CORNER_MODE= 2+4
```

SEE ALSO:
CORNER_STATE, DECEL_ANGLE, FULL_SP_RADIUS, RAISE_ANGLE, STOP_ANGLE

CORNER_STATE

TYPE:
Axis Parameter

DESCRIPTION:

Allows a **BASIC** program to interact with the move loading process.

This can be used to facilitate tool adjustment such as knife rotation at sharp corners.

This parameter is only active when **CORNER_STATE** bit 2 is set. It is also required to use bit 1 of **CORNER_STATE** with **STOP_ANGLE** set to less than or equal to **RAISE_ANGLE** to stop the motion.

VALUE:

0	Load move and ramp up speed
1	Ready to load move, stopped
3	Load move

EXAMPLE:

When a transition exceeds **RAISE_ANGLE** it is required to lift a cutting knife and rotate it to a new position. The following process is required:

1. System sets **CORNER_STATE** to 1 to indicate move ready to be loaded with large angle change.
2. BASIC program raises knife.
3. BASIC program sets **CORNER_STATE** to 3.
4. System will load following move but with speed overridden to zero. This allows the direction to be obtained from **TANG_DIRECTION**.
5. BASIC program orients knife possibly using **MOVETANG**.
6. BASIC program clears **CORNER_STATE** to 0.
7. System will ramp up speed to perform the next move.

```
MOVEABSSP(x,y)
IF CHANGE_DIR_LAST>RAISE_ANGLE THEN
  WAIT UNTIL CORNER_STATE>0
  'Raise Knife
  MOVE(100) AXIS(z)
  CORNER_STATE=3
  WA(10)
  WAIT UNTIL VP_SPEED AXIS(2)=0
  'Rotate Knife
  MOVETANG(0,x) AXIS(r)
  'Lower Knife
  MOVE(-100) AXIS(z)
  'Resume motion
  CORNER_STATE=0
```

```
    ENDIF
```

SEE ALSO:
`CORNER_MODE, RAISE_ANGLE, STOP_ANGLE`

COS

TYPE:
Mathematical Function

SYNTAX:
```
value = COS(expression)
```

DESCRIPTION:
Returns the **`COSINE`** of an expression. Input values are in radians.

PARAMETERS:

value:	The **`COSINE`** of the expression
expression:	Any valid TrioBASIC expression.

EXAMPLE:
Print the cosine of zero to the command line with 3 decimal places
```
    >>PRINT COS(0)[3]
    1.000
```

CPU_EXCEPTIONS

TYPE:
Reserved Keyword

CRC16

TYPE:
Mathematical Command

SYNTAX:
`result = CRC16(mode,{parameters})`

DESCRIPTION:
Calculates a 16 bit Cyclic Redundancy Check (CRC) of data stored in contiguous Table Memory or **VR** Memory locations.

PARAMETERS:

mode:	0	Initialise the polynomial
	1	Calculate the CRC

MODE = 0:

SYNTAX:
`result = CRC16(0, poly)`

DESCRIPTION:
Initialises the command with the Polynomial

PARAMETERS:

result:	Always returns -1
poly:	Polynomial used as seed for CRC check range 0-65535 (or 0-$**FFFF**)

MODE = 1:

SYNTAX:
`result = CRC16(1, source, start, end, initial)`

DESCRIPTION:
Calculates the CRC

PARAMETERS:

result:	Returns the result of the CRC calculation. Will be 0 if the calculation fails.

source:	Defines where the data is loaded	
	0	Table Memory
	1	**VR** Memory
start:	Start location of first byte	
end:	End Location of last byte	
initial:	Initial CRC value. Normally $0 - $**FFFF**	

EXAMPLES:

EXAMLPE 1:
Calculate the CRC using Table Memory:

```
    poly = $8005
    CRC16(0, poly) 'Initialise internal CRC table memory

    TABLE(0,1,2,3,4,5,6,7,8) *load data into TABLE memory location 0-7
    reginit = 0
    calc_crc = CRC16(1,0,0,7,reginit) 'Source Data=TABLE(0..7)
```

EXAMPLE 2:
Calculate the CRC using **VR**s:

```
    ' generate CRC lookup table
    poly=$8005
    CRC16(0,poly)

    ' create test data as "hello"
    VR(100)=104
    VR(101)=101
    VR(102)=108
    VR(103)=108
    VR(104)=111
    VR(105)=0
    VR(106)=0
    PRINT VRSTRING(100)

    ' calculate the crc16
    crc=0
    crc=CRC16(1,1,100,104,crc)

    ' print the result
    PRINT HEX(crc)
```

CREEP

TYPE:
Axis Parameter

DESCRIPTION:
Sets the **CREEP** speed on the current base axis. The creep speed is used for the slow part of a **DATUM** sequence.

VALUE:
Any positive value in user **UNITS**

EXAMPLE:
Set up the **CREEP** speeds on 2 axes and then perform a **DATUM** routine.

```
BASE(2)
CREEP=10
SPEED=500
DATUM(4)
CREEP AXIS(1)=10
SPEED AXIS(1)=500
DATUM(4) AXIS(1)
```

SEE ALSO:
DATUM

D_GAIN

TYPE:
Axis Parameter

DESCRIPTION:
Used as part of the closed loop control, adding derivative gain to a system is likely to produce a smoother response and allow the use of a higher proportional gain than could otherwise be used.

High values may lead to oscillation. For a derivative term K_d and a change in following error de the contribution to the output O_d signal is:

$$O_d = K_d \times \delta_e$$

VALUE:
The derivative gain is a constant which is multiplied by the change in following error. Default value = 0

EXAMPLE:
Setting the gain values as part of a **STARTUP** program

```
P_GAIN=1
I_GAIN=0
D_GAIN=0.25
OV_GAIN=0
…
```

D_ZONE_MAX

TYPE:
Axis Parameter

DESCRIPTION:
Working in conjunction with **D_ZONE_MIN**, **D_ZONE_MAX** defines a DAC dead band. This clamps the DAC output to zero when the demand movement is complete and the magnitude of the following error is less than the **D_ZONE_MIN** value. The servo loop will be reactivated when either the following error rises above the **D_ZONE_MAX** value, or a fresh movement is started.

This can be used to prevent oscillations at static positions in Piezo systems.

VALUE:
Above this value the servo loop is reactivated when clamped in the dead band.

EXAMPLE:

The DAC output will be clamped at zero when the movement is complete and the following error falls below 3. When a movement is restarted or if the following error rises above a value of 10, the servo loop will be reactivated

```
    D_ZONE_MIN = 3
    D_ZONE_MAX = 10
```

SEE ALSO:

`D_ZONE_MIN`

D_ZONE_MIN

TYPE:

Axis Parameter

DESCRIPTION:

Working in conjunction with **`D_ZONE_MAX`**, **`D_ZONE_MIN`** defines a DAC dead band. This clamps the DAC output to zero when the demand movement is complete and the magnitude of the following error is less than the **`D_ZONE_MIN`** value. The servo loop will be reactivated when either the following error rises above the **`D_ZONE_MAX`** value, or a fresh movement is started.

This can be used to prevent oscillations at static positions in Piezo systems.

VALUE:

When the axis is **`IDLE`** and the magnitude of the following error is less than this value the DAC is clamped to zero.

EXAMPLE:

The DAC output will be clamped at zero when the movement is complete and the following error falls below 3. When a movement is restarted or if the following error rises above a value of 10, the servo loop will be reactivated

```
    D_ZONE_MIN = 3
    D_ZONE_MAX = 10
```

SEE ALSO:

`D_ZONE_MAX`

DAC

TYPE:

Axis Parameter

DESCRIPTION:

Writing to this parameter when **SERVO** = OFF and **AXIS_ENABLE** = ON allows the user to force a demand value for that axis. On an analogue axis this will set a voltage on the output. On a digital axis this will be the demand value.

When using a FlexAxis as a stepper or encoder output or anytime with **SERVO** = **OFF** the voltage outputs are available for user control.

The **WDOG** and **AXIS_ENABLE** must be ON for the demand value to be set. When the **WDOG** or **AXIS_ENABLE** is OFF you can write a value to DAC but the actual output (**DAC_OUT**) will be at 0.

VALUE:

The demand value for the axis

For a 12 bit DAC on an analogue axis:

DAC	Voltage
-2048	10V
2047	-10V

For a 16 bit DAC on an analogue axis:

DAC	Voltage
32767	10V
-32768	-10V

For digital axes check the drive specification for suitable values.

EXAMPLE:

To force a square wave of amplitude +/-5V and period of approximately 500ms on axis 0.

```
WDOG=ON
SERVO AXIS(0)=OFF
square:
  DAC AXIS(0)=1024
  WA(250)
```

```
      DAC AXIS(0)=-1024
      WA(250)
    GOTO square
```

SEE ALSO:

DAC_OUT, DAC_SCALE, SERVO

DAC_OUT

TYPE:

Axis Parameter (Read Only)

DESCRIPTION:

DAC_OUT reads the demand value for the axis.

In an analogue system this will be the value sent to the voltage output (the DAC). If **SERVO** = ON this is the output of the closed loop algorithm. If **SERVO** = OFF it is the value set by the user in DAC

In a digital system it returns the demand value for the axis which could be the actual position, speed or torque depending on the axis **ATYPE**.

VALUE:

Demand value for the axis

EXAMPLE:

To check that the controller has set the correct voltage for axis 8 on an analogue system read **DAC_OUT** in the command line.

```
    >>PRINT DAC_OUT AXIS(8)
    288.0000
    >>
```

SEE ALSO:

DAC, DAC_SCALE, ATYPE

DAC_SCALE

TYPE:

Axis Parameter

DESCRIPTION:

DAC_SCALE is an integer that is multiplied to the output of the closed loop algorithm. You can use it to reverse the polarity of the demand value or to scale it so to effectively reduce the resolution of the closed loop algorithm.

As it is applied to the output of the closed loop algorithm it is not applied to position based axis.

VALUE:
Can be a positive or negative integer. The default values are shown in the following table:

MC464 Ethercat	1
MC464 Sercos	1
MC464 FlexAxis	16
MC464 Panasonic	16
MC464 SLM	16
MC405	1
MC403	1

To obtain the highest possible resolution of your system **DAC_SCALE** should be set to 1 or -1.

To avoid problems with the multiply by 16, **DAC_SCALE** should be set to 1 for an **SLM** axis

EXAMPLE:

EXAMPLE 1:
The FlexAxis uses a 16bit DAC. To make it compatible with the gain settings used on older 12 bit DACs, **DAC_SCALE** is set to 16.

The max output from closed loop algorithm is 2048 (for a 12bit system)

The max output from a 16bit DAC is 32768 which is 2048 multiplied by 16

EXAMPLE 2:
Set up an axis to work in the reverse direction. For a servo axis, both the **DAC_SCALE** and the **ENCODER_RATIO** must be set to minus values.

```
BASE(2)  ` set axis 2 to work in reverse direction
DAC_SCALE = -1
ENCODER_RATIO(-1,1)
```

SEE ALSO:
DAC, DAC_OUT, ENCODER_RATIO

DATE$

TYPE:
String Function

SYNTAX:
DATE$

DESCRIPTION:
DATE$ is used as part of a **PRINT** statement or a **STRING** variable to write the current date from the real time clock. The date is printed in the format DD/MMM/**YYYY**. The month is displayed in short text form.

The **DATE$** is set through the **DATE** command

PARAMETERS:
None.

EXAMPLES:

EXAMPLE 1:
This will print the date in format for example 20th October 2010 will print the value: 20/Oct/2010

```
PRINT #5,DATE$
```

EXAMPLE 2:
Create an error message to print later in the program

```
DIM string1 AS STRING(30)
string1 = "Error occurred on the " + DATE$
```

DATE

TYPE:
System Function

DESCRIPTION:
Returns or sets the current date held by the real time clock.

SETTING THE DATE:

SYNTAX:
DATE=dd:mm:yy

DESCRIPTION:
Sets the date using the two digit year format or the four digit year format.

PARAMETERS:

dd:	day in two digit numeric format
mm:	Month in two digit numeric format
yy:	last two digits of the year using the range 00-99 representing 2000-2099 OR the full four digits of the year using the range 2000-2099

Years outside the range 2000-2099 are invalid.

EXAMPLE:
Set the date to the 20th October 2012

```
    >>DATE=20:10:12
```

or

```
    >>DATE=20:10:2012
```

READING THE DATE:

SYNTAX:
`Value = DATE({mode})`

DESCRIPTION:
Read the date value from the real time clock as a number.

PARAMETERS:

mode	value
none	The number of days since 01/01/2000 (with 01/01/2000 = 0)
0	The day of the current month
1	The month of the current year
2	The current year

EXAMPLES:

EXAMPLE 1:
Print the number of days since 1st January 2000 (with the 1st being day 0)

```
>>PRINT DATE
4676
>>
```

EXAMPLE 2:
Set a date then print it out using the US format

```
>>DATE=05:08:2008
>>PRINT DATE(1);"/";DATE(0);"/";DATE(2) 'Prints the date in US format.
08/05/2008
>>
```

DATUM

TYPE:
Axis Command

SYNTAX:
`DATUM(sequence)`

DESCRIPTION:
Performs one of 6 datuming sequences to locate an axis to an absolute position. The creep speed used in the sequences is set using **CREEP**. The programmed speed is set with the **SPEED** command.

DATUM(0) is a special case used for resetting the system after an axis critical error. It leaves the positions unchanged.

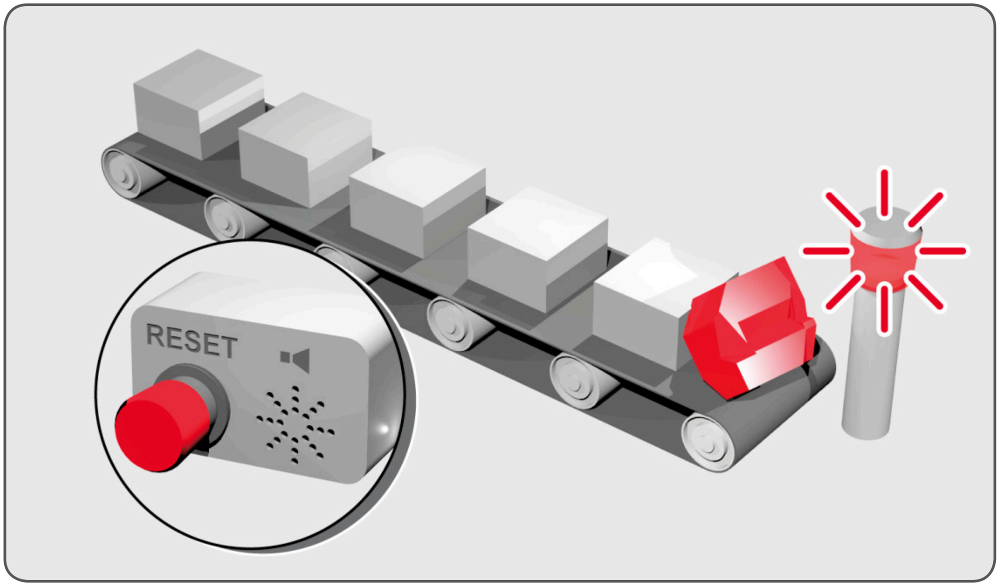
PARAMETER:

Sequence	Description
0	**DATUM**(0) clears the following error exceeded **FE_LIMIT** condition for ALL axes by setting these bits in **AXISSTATUS** to zero: **BIT 1** Following Error Warning **BIT 2** Remote Drive Comms Error **BIT 3** Remote Drive Error **BIT 8** Following Error Limit Exceeded **BIT 11** Cancelling Move
1	The axis moves at creep speed forward till the Z marker is encountered. The Measured position is then reset to zero and the Demand position corrected so as to maintain the following error.
2	The axis moves at creep speed in reverse till the Z marker is encountered. The Measured position is then reset to zero and the Demand position corrected so as to maintain the following error.
3	The axis moves at the programmed speed forward until the datum switch is reached. The axis then moves backwards at creep speed until the datum switch is reset. The Measured position is then reset to zero and the Demand position corrected so as to maintain the following error.
4	The axis moves at the programmed speed reverse until the datum switch is reached. The axis then moves at creep speed forward until the datum switch is reset. The Measured position is then reset to zero and the Demand position corrected so as to maintain the following error.
5	The axis moves at programmed speed forward until the datum switch is reached. The axis then reverses at creep speed until the datum switch is reset. It then continues in reverse at creep speed looking for the Z marker on the motor. The Measured position where the Z input was seen is then set to zero and the Demand position corrected so as to maintain the following error.
6	The axis moves at programmed speed reverse until the datum switch is reached. The axis then moves forward at creep speed until the datum switch is reset. It then continues forward at creep speed looking for the Z marker on the motor. The Measured position where the Z input was seen is then set to zero and the Demand position corrected so as to maintain the following error.
7	Clear **AXISSTATUS** error bits for the **BASE** axis only. Otherwise the action is the same as **DATUM**(0).

The datuming input set with the **DATUM_IN** which is active low so is set when the input is **OFF**. This is similar to the **FWD**, **REV** and **FHOLD** inputs which are designed to be “fail-safe”.

EXAMPLES:

EXAMPLE 1:
A production line is forced to stop if something jams the product belt, this causes a motion error. The obstacle has to be removed, then a reset switch is pressed to restart the line.

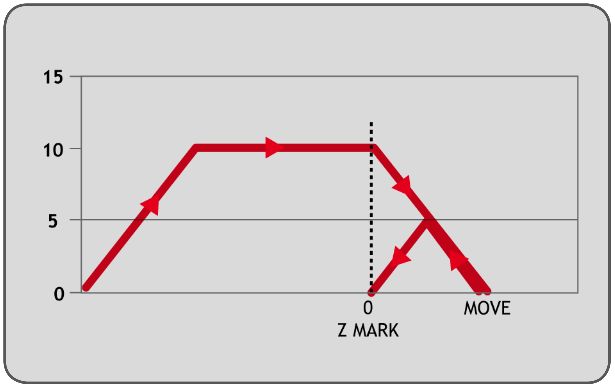


```
FORWARD                    'start production line
WHILE IN(2)=ON
  IF MOTION_ERROR=0 THEN
     OP(8,ON)              'green light on; line is in motion
        ELSE
     OP(8, OFF)
    GOSUB error_correct
  ENDIF
WEND
CANCEL
STOP

error_correct:
   REPEAT
    OP(10,ON)
    WA(250)
    OP(10,OFF)             'flash red light to show crash
    WA(250)
```

```
      UNTIL IN(1)=OFF
     DATUM(0)                 'reset axis status errors
     SERVO=ON                 'turn the servo back on
     WDOG=ON                  'turn on the watchdog
     OP(9,ON)                 'sound siren that line will restart
     WA(1000)
     OP(9,OFF)
     FORWARD                  'restart motion
   RETURN
```

EXAMPLE 2:

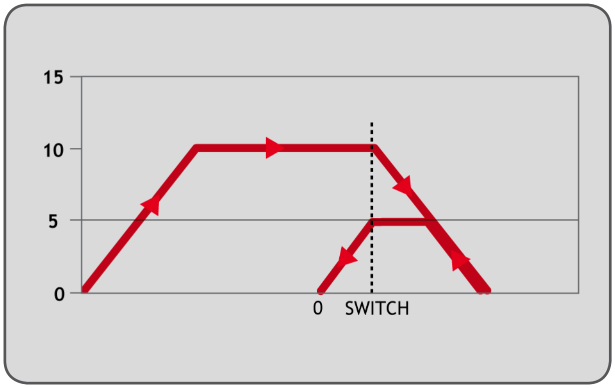
An axis requires its position to be defined by the Z marker. This position should be set to zero and then the axis should move to this position. Using the datum 1 the zero point is set on the Z mark, but the axis starts to decelerate at this point so stops after the mark. A move is then used to bring it back to the Z position.



```
   SERVO=ON
   WDOG=ON
   CREEP=1000     'set the search speed
   SPEED=5000     'set the return speed
   DATUM(1)       'register on Z mark and sets this to datum
   WAIT IDLE
   MOVEABS (0)     'moves to datum position
```

EXAMPLE 3:

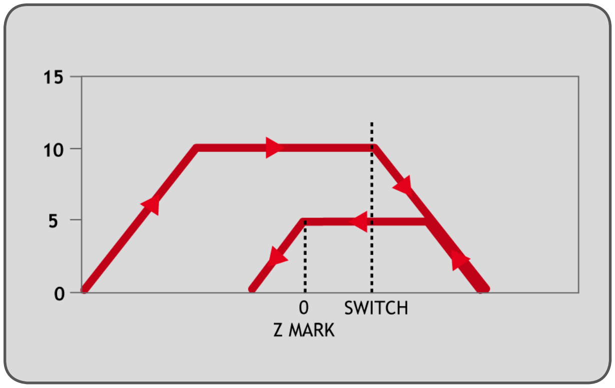
A machine must home to its limit switch which is found at the rear of the travel before operation. This can be achieved through using **DATUM**(4) which moves in reverse to find the switch.



```
SERVO=ON
WDOG=ON
REV_IN=-1     'temporarily turn off the limit switch function
DATUM_IN=5    'sets input 5 for registration
SPEED=5000    'set speed, for quick location of limit switch
CREEP=500     'set creep speed for slow move to find edge of switch
DATUM(4)      'find "edge" at creep speed and stop
WAIT IDLE
DATUM_IN=-1
REV_IN=5      'restore input 5 as a limit switch again
```

EXAMPLE 4:

A similar machine to Example 3 must locate a home switch, which is at the forward end of travel, and then move backwards to the next Z marker and set this as the datum. This is done using **DATUM**(5) which moves forwards at speed to locate the switch, then reverses at creep to the Z marker. A final move is then needed, if required, as in Example 2 to move to the datum Z marker.



```
    SERVO=ON
    WDOG=ON
    DATUM_IN=7   'sets input 7 as home switch
    SPEED=5000   'set speed, for quick location of switch
    CREEP=500    'set creep speed for slow move to find edge of switch
    DATUM(5)     'start the homing sequence
    WAIT IDLE
```

SEE ALSO:

CREEP, DATUM_IN

DATUM_IN

TYPE:

Axis Parameter

ALTERNATE FORMAT:

DAT_IN

DESCRIPTION:

This parameter holds a digital input channel to be used as a datum input.

The input used for **DATUM_IN** is active low.

VALUE:

-1	disable the input as **DATUM_IN** (default)
0-IO_Max	Input to use as datum input

Any type of input can be used, built in, Trio CAN I/O, CANopen, EtherCAT or virtual.

EXAMPLE:

Set input 28 as the **DATUM** input for axis 0 then perform a homing routine

```
    DATUM_IN AXIS(0)=28
    DATUM(3)
```

SEE ALSO:

DATUM

DAY$

TYPE:
String Function

SYNTAX:
DAY$

DESCRIPTION:
Used as part of a **PRINT** statement or a **STRING** variable to write the current day as a string.

The **DAY**$ is set through the **DATE** command

EXAMPLES:

EXAMPLE 1:
Print the day as part of a welcome message:

```
    PRINT#5, "Welcome to Trio on "; DAY$
```

EXAMPLE 2:
Create a header to be used when writing a log to the SD card.

```
    DIM header AS STRING(30)
    header = DAY$ + "Start of production"
```

SEE ALSO:
DATE, DATE$, DAY, PRINT, STRING

DAY

TYPE:
System Function

SYNTAX:
value = DAY

DESCRIPTION:
Returns the current day as a number.

The **DAY** is set through the **DATE** command

RETURN VALUE:
0..6, Sunday is 0

EXAMPLE:
Print some text depending on the day

```
    IF DAY=2 THEN
        PRINT#5, "Change filter"
    ENDIF
```

SEE ALSO:
DATE, DAY$

DECEL

TYPE:
Axis Parameter

DESCRIPTION:
The **DECEL** axis parameter may be used to set or read back the deceleration rate of each axis fitted.

VALUE:
The deceleration rate in **UNITS**/sec/sec. Must be a positive value.

EXAMPLE:
Set the deceleration parameter and print it to the user.

```
    DECEL=100' Set deceleration rate
    PRINT " Decel is ";DECEL;" mm/sec/sec"
```

SEE ALSO:
ACCEL

DECEL_ANGLE

TYPE:
Axis Parameter

DESCRIPTION:
This parameter is used with **CORNER_MODE**, it defines the maximum change in direction of a 2 axis

interpolated move that will be merged at full speed. When the change in direction is greater than this angle the speed will be proportionally reduced so that:

VP_SPEED=**FORCE_SPEED** * (angle - **DECEL_ANGLE**) / (**STOP_ANGLE** - **DECEL_ANGLE**)

Where angle is the change in direction of the moves.

VALUE:

The angle to start to reduce the speed, in radians.

EXAMPLE:

Decelerate to a slower speed when the transition is between 15 and 45 degrees.

```
    CORNER_MODE=2
    DECEL_ANGLE = 15 * (PI/180)
    STOP_ANGLE = 45 * (PI/180)
```

SEE ALSO:

CORNER_MODE, STOP_ANGLE

DEFPOS

TYPE:

Axis Command

SYNTAX:

DEFPOS(pos1 [,pos2[, pos3[, pos4...]]])

ALTERNATE FORMAT:

DP(pos1 [,pos2[, pos3[, pos4...]]])

DESCRIPTION:

Defines the current position(s) as a new absolute value. The value pos# is placed in **DPOS**, while **MPOS** is adjusted to maintain the FE value. This function is completed after the next servo-cycle. **DEFPOS** may be used at any time, even whilst a move is in progress, but its normal function is to set the position values of a group of axes which are stationary.

PARAMETERS:

pos1:	Absolute position to set on current base axis in user units.
pos2:	Abs. position to set on the next axis in **BASE** array in user units.
pos3:	Abs. position to set on the next axis in **BASE** array in user units.

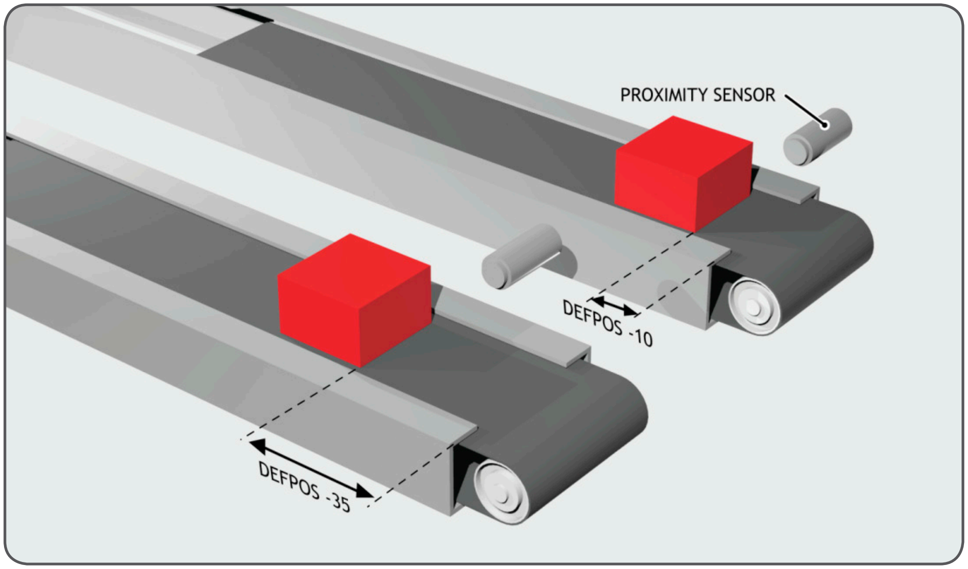
...	

As many parameters as axes on the system may be specified.

EXAMPLES:

EXAMPLE 1:

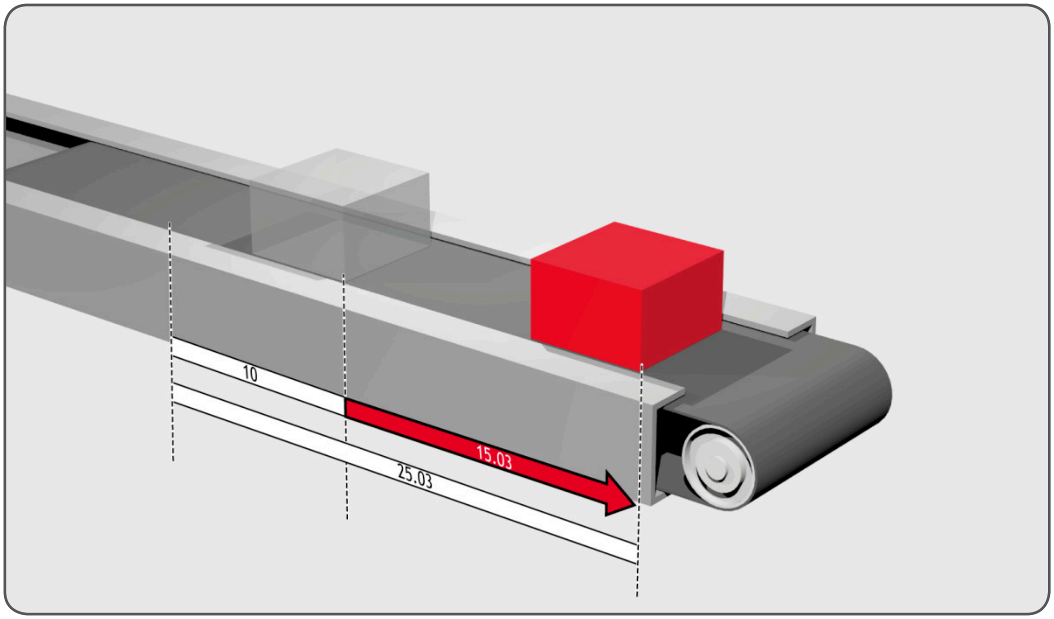
After homing 2 axes, it is required to change the **DPOS** values so that the “home” positions are not zero, but some defined positions instead.



```
DATUM(5) AXIS(1)    'home both axes.  At the end of the DATUM
DATUM(4) AXIS(3)    'procedure, the positions will be 0,0.
WAIT IDLE AXIS(1)
WAIT IDLE AXIS(3)
BASE(1,3)           'set up the BASE array
DEFPOS(-10,-35)  'define positions of the axes to be -10 and -35
```

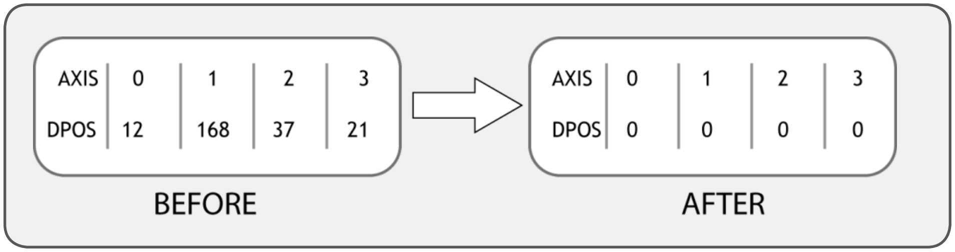
EXAMPLE 2:

Define the axis position to be 10, then start an absolute move, but make sure the axis has updated the position before loading the **MOVEABS**.



```
DEFPOS(10.0)
WAIT UNTIL OFFPOS=0' Ensures DEFPOS is complete before next line
MOVEABS(25.03)
```

EXAMPLE 3:
From the *Motion* Perfect terminal, quickly set the **DPOS** values of the first four axes to 0.



BEFORE

AXIS	0	1	2	3
DPOS	12	168	37	21

AFTER

AXIS	0	1	2	3
DPOS	0	0	0	0

```
>>BASE(0)
>>DEFPOS(0,0,0,0)
>>
```

SEE ALSO:
OFFPOS

DEL

TYPE:
System Command

SYNTAX:
`DEL "program"`

ALTERNATE FORMAT:
`RM "program"`

DESCRIPTION:
Used to delete a program form the controller memory.

This command should not be used from within *Motion* Perfect.

PARAMETERS:

program:	the name of the program to be deleted

EXAMPLE:
Delete an old program

```
    >>DEL "oldprog"
    OK
    >>
```

DEMAND_EDGES

TYPE:
Axis Parameter (Read Only)

DESCRIPTION:
Allows the user to read back the current **`DPOS`** in encoder edges.

You can use **`DEMAND_EDGES`** to check that your **`UNITS`** or **`ENCODER_RATIO`** values are set correctly.

VALUE:
Demand position in encoder edges.

EXAMPLE:
Print the **DEMAND_EDGES** in the command line

```
>>PRINT DEMAND_EDGES AXIS(4)
523
>>
```

DEMAND_SPEED

TYPE:
Axis Parameter (Read Only)

DESCRIPTION:
Returns the speed output of the VPU, this is normally used for low level debug of the motion system.

VALUE:
VPU speed output in user **UNITS** per servo period.

EXAMPLE:
Check the VPU speed output using the command line

```
>>?DEMAND_SPEED
5.0000
>>
```

DEVICENET

TYPE:
System Command

SYNTAX:
DEVICENET(slot, function[,parameters…])

DESCRIPTION:
The command **DEVICENET** is used to start and stop the DeviceNet slave function which is built into the *Motion Coordinator*.

Polled IO data is transferred periodically:

From PLC to [**TABLE**(poll_base) -> **TABLE**(poll_base + poll_in)]
To PLC from [**TABLE**(poll_base + poll_in + 1) -> **TABLE**(poll_base + poll_in + poll_out)]

PARAMETERS:

slot:	Set -1 for built-in CAN port	
function:	0	Start the DeviceNet slave protocol on the given slot.
	1	Stop the DeviceNet protocol.
	2	Put startup baudrate into Flash EPROM

FUNCTION = 0:

SYNTAX:
```
DEVICENET(slot, 0, baud, mac_id, poll_base, poll_in, poll_out)
```

DESCRIPTION:
Start the DeviceNet protocol using the specified parameters

PARAMETERS:

baud:	Set to 125, 250 or 500 to specify the baud rate in kHz.
mac_id:	The ID which the *Motion Coordinator* will use to identify itself on the DeviceNet network. Range 0..63.
poll_base:	The first **TABLE** location to be transferred as poll data
poll_in:	Number of words to be received during poll. Range 0..4
poll_out:	Number of words to be sent during poll. Range 0..4

FUNCTION = 1:

SYNTAX:
```
DEVICENET(slot, 1)
```

DESCRIPTION:
Stop the DeviceNet protocol from running

FUNCTION = 2:

SYNTAX:
`DEVICENET(slot, 2, baud)`

DESCRIPTION:
Store the baud rate in flash EPROM for power up.

PARAMETERS:

baud:	Set to 125, 250 or 500 to specify the baud rate in kHz.

EXAMPLES:

EXAMPLE 1:
Start the DeviceNet protocol on the built-in CAN port
```
    DEVICENET(-1,0,500,30,0,4,2)
```

EXAMPLE 2:
Stop the DeviceNet protocol on the CAN board in slot 2;
```
    DEVICENET(2,1)
```

EXAMPLE 3:
Set the CAN board in slot 0 to have a baud rate of 125k bps on power-up;
```
    DEVICENET(0,2,125)
```

DIM.. AS.. BOOLEAN/ FLOAT/ INTEGER/STRING

TYPE:
Declaration

SYNTAX:
```
DIM name AS type
DIM name AS FLOAT [(length)]
DIM name AS INTEGER [(length)]
DIM name AS STRING(length)
```

DESCRIPTION
By default local variables are type **FLOAT** and do not require declaration. It is possible to declare other types of values using the DIM declaration. **BOOLEAN**, **FLOAT**, **INTEGER** and **STRING** can be declared. It is also possible to make arrays of numerical types.

If **COMPILE_MODE** =1 then all local variables must be declared.

Local variables can be declared in an **INCLUDE** file.

TYPES:

BOOLEAN	1bit binary value (**TRUE** or **FALSE**)
FLOAT	64bit floating point number (default)
INTEGER	64bit signed integer value
STRING	**ASCII** text

TYPE = BOOLEAN:

SYNTAX:

```
DIM name AS BOOLEAN[(size [,size [,size]])]
```

DESCRIPTION:

Declare a variable as a **BOOLEAN** value. This can be used with **TRUE** and **FALSE**, any non-zero value written to a **BOOLEAN** variable will set its state to **TRUE**.

PARAMETERS:

name:	Any user-defined name containing lower case alpha, numerical or underscore (_) characters.
size:	The size of the array of **BOOLEAN**, up to 3 dimensions.

The size must be a number. You cannot use local variables, **VR** etc to set this value.

EXAMPLES:

Use a local variable as a flag to track the ok status of a machine.

```
DIM machine_ok AS BOOLEAN

machine_ok = TRUE

WHILE machine_ok = TRUE
  IF MOTION_ERROR <> 0 AND IN(0) = TRUE THEN
    machine_ok =FALSE
  ENDIF
WEND
```

TYPE = FLOAT:

SYNTAX:

`DIM name AS FLOAT[(size [,size [,size]])]`

DESCRIPTION:

Declare a variable as a floating point value.

PARAMETERS:

name:	Any user-defined name containing lower case alpha, numerical or underscore (_) characters.
size:	The size of the array of **FLOAT**, up to 3 dimensions.

The size must be a number. You cannot use local variables, **VR** etc to set this value.

EXAMPLES:

Use an array of positions to run a sequence of moves.

```
    DIM position AS FLOAT(10)

    position(0) = 0
    position(1) = 10.3214
    position(2) = 15.123
    position(3) = 20.77569
    position(4) = 25.2215
    position(5) = 22.37895
    position(6) = 21.7897
    position(7) = 20.1457
    position(8) = 15.4457
    position(9) = 0

    FOR x = 0 TO 9
     MOVEABS(position(x))
    NEXT x
```

TYPE = INTEGER:

SYNTAX:

`DIM name AS INTEGER[(size [,size [,size]])]`

DESCRIPTION:

Declare a variable as an integer value. If a floating point number is assigned to an integer variable then the decimal part is truncated.

PARAMETERS:

name:	Any user-defined name containing lower case alpha, numerical or underscore (_) characters.
size:	The size of the array of **INTEGER**, up to 3 dimensions.

The size must be a number. You cannot use local variables, **VR** etc to set this value.

EXAMPLES:

Declare a local variable as an integer to use when reading in characters from the serial port.

```
DIM character AS INTEGER
DIM message AS STRING(200)

WHILE KEY#1
  GET#1, character
  message = message + CHR(character)
WEND
```

TYPE = STRING:

SYNTAX:

DIM name AS STRING(length)

DESCRIPTION:

Declare a variable as a string so that you can use it in **PRINT** statements, part of a logical condition or anywhere in the TrioBASIC that uses text. The variable can be assigned by any function or parameter that generates a string or manually.

You can use the **STR** function to change a numerical value to a string.

PARAMETERS:

name:	Any user-defined name containing lower case alpha, numerical or underscore (_) characters.
length:	Maximum number of characters that the variable can hold

The length must be a number. You cannot use local variables, **VR** etc to set this value.

EXAMPLES:

EXAMPLE 1:

Pre-define a set of error strings to use later:

```
DIM error1 AS STRING(20)
error1 = “Feed jammed”
DIM error2 AS STRING(20)
error2 = “Cutter jammed”
DIM error3 AS STRING(20)
error3 = “Out of material”

display_error:
IF error_number = 1 then
  PRINT error1
ELSEIF error_number = 2 then
  PRINT error2
ELSE
  PRINT error3
ENDIF
```

EXAMPLE 2:

Read in characters from a channel and append them to a string variable then finally printing them.

```
DIM captured_text AS STRING(50)
WHILE char<>13 OR count>50
  TICKS=10000 ‘5 second timeout on character
  WAIT UNTIL KEY#5 OR TICKS<0
  IF TICKS<0 THEN
    count=100 ‘exit loop
  ELSE
    GET#5,char
    captured_text = captured_text + CHR(char)
    count=count+1
  ENDIF
WEND
PRINT captured_text
```

EXAMPLE 3:

Using a string variable decide which motion routine to execute:

```
IF g_value = “G00” THEN ‘ rapid positioning
  SPEED = fast_speed
  MOVE(x,y,z)
  WAIT IDLE
  SPEED = standard_speed
ELSEIF g_value = “G01” THEN ‘ linear move
```

```
        MOVE(x,y,z)
      ELSEIF g_value = “G02” THEN ‘ anticlockwise circular move
        MOVECIRC(x,y,x+i_value,y+j_value,0)
      ELSEIF g_value = “G03” THEN ‘ clockwise circular move
        MOVECIRC(x,y,x+i_value,y+j_value,1)
      ELSE
        PRINT “Ignoring unsupported token: “;g_value
      ENDIF
```

SEE ALSO:
CHR, COMPILE_MODE, HEX, DATE$, DAY$, TIME$

DIR

TYPE:
System Command (command line only)

SYNTAX:
DIR [option]

ALTERNATE FORMAT:
LS [option]

DESCRIPTION:
Prints a list of all programs including their size and **RUNTYPE**.

PARAMETERS:

Parameter	Function
none	Directory listing of controller memory
d	Directory listing of SD card memory
s	Reserved function
x	Extended listing of controller memory (used by *Motion* Perfect).

DISABLE_GROUP

TYPE:
System Command

SYNTAX:
`DISABLE_GROUP(parameter[,parameters…])`

DESCRIPTION:
Used to create a group of axes which will be disabled if there is a motion error in one or more of the group. After the group is created, when an error occurs all the axes in the group will have their **AXIS_ENABLE** set to OFF and **SERVO** set to OFF.

Multiple groups can be made, although one axis cannot belong to more than one group.

Only axes that have individual enables should be used in a disable group. Such as Digital drives and Steppers.

DISABLE_GROUP(-1)

SYNTAX:
`DISABLE_GROUP(-1)`

DESCRIPTION:
Clears all groups

DISABLE_GROUP(AXIS1…)

SYNTAX:
`DISABLE_GROUP(axis1 [,axis2[, axis3[, axis4.....]]])`

DESCRIPTION:
Assigns the listed axis to a group

PARAMETERS:

axis1:	Axis number of first axis in group
axis2:	Axis number of second axis in group.
axisN:	Axis number of Nth axis in group.

As many parameters as axes on the system may be specified.

EXAMPLES:

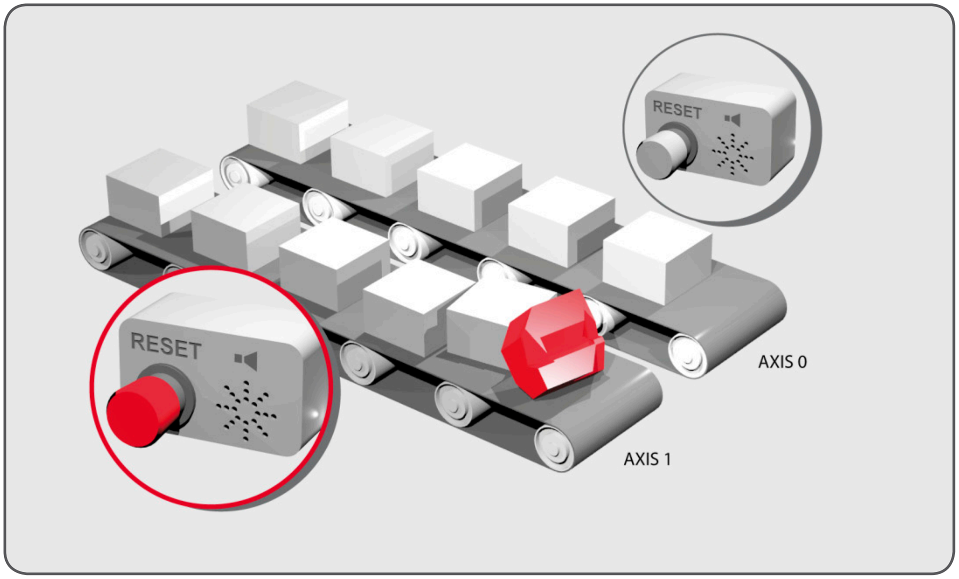
EXAMPLE 1:

A machine has 2 functionally separate systems, which have their own emergency stop and operator protection guarding. If there is an error on one part of the machine, the other part can safely remain running while the cause of the error is removed and the axis group re-started. We need to set up 2 separate axis groupings.

```
DISABLE_GROUP(-1)        'remove any previous axis groupings
DISABLE_GROUP(0,1,2,6)   'group axes 0 to 2 and 6
DISABLE_GROUP(3,4,5,7)   'group axes 3 to 5 and 7
WDOG=ON 'turn on the enable relay and the remote drive enable
FOR ax=0 TO 7
  AXIS_ENABLE AXIS(ax)=ON  'enable the 8 axes
  SERVO AXIS(ax)=ON 'start position loop servo for each axis
NEXT ax
```

EXAMPLE 2:

Two conveyors operated by the same *Motion Coordinator* are required to run independently so that if one has a "jam" it will not stop the second conveyor.



```
DISABLE_GROUP(0) 'put axis 0 in its own group
DISABLE_GROUP(1) 'put axis 1 in another group
GOSUB group_enable0
GOSUB group_enable1
WDOG=ON
FORWARD AXIS(0)
FORWARD AXIS(1)

WHILE TRUE
  IF AXIS_ENABLE AXIS(0)=0 THEN
    PRINT "motion error axis 0"
    reset_0_flag=1
  ENDIF
  IF AXIS_ENABLE AXIS(1)=0 THEN
    PRINT "motion error axis 1"
    reset_1_flag=1
  ENDIF
  IF reset_0_flag=1 AND IN(0)=ON THEN
    GOSUB group_enable0
    FORWARD AXIS(0)
    reset_0_flag=0
  ENDIF
  IF reset_1_flag=1 AND IN(1)=ON THEN
    GOSUB group_enable1
    FORWARD AXIS(1)
    reset_1_flag=0
  ENDIF
WEND

group_enable0:
  BASE(0)
  DATUM(7)  ' clear motion error on axis 0
  WA(10)
  AXIS_ENABLE=ON
  SERVO=ON
RETURN
group_enable1:
  BASE(1)
  DATUM(7)  ' clear motion error on axis 0
  WA(10)
  AXIS_ENABLE=ON
  SERVO=ON
RETURN
```

EXAMPLE 3:

One group of axes in a machine requires resetting, without affecting the remaining axes, if a motion error occurs. This should be done manually by clearing the cause of the error, pressing a button to clear the controllers’ error flags and re-enabling the motion.

```
      DISABLE_GROUP(-1)       ‘remove any previous axis groupings
      DISABLE_GROUP(0,1,2)    ‘group axes 0 to 2
      GOSUB group_enable      ‘enable the axes and clear errors
      WDOG=ON
      SPEED=1000
      FORWARD

      WHILE IN(2)=ON    ‘check axis 0, but all axes in the group
                        ‘will disable together
        IF AXIS_ENABLE =0 THEN
          PRINT “Motion error in group 0”
          PRINT “Press input 0 to reset”
          IF IN(0)=0 THEN       ‘checks if reset button is pressed
            GOSUB group_enable  ‘clear errors and enable axis
            FORWARD             ‘restarts the motion
          ENDIF
        ENDIF
      WEND
      STOP              ‘stop program running into sub routine

    group_enable:       ‘Clear group errors and enable axes
      DATUM(0)          ‘clear any motion errors
      WA(10)
      FOR axis_no=0 TO 2
        AXIS_ENABLE AXIS(axis_no)=ON  ‘enable axes
        SERVO AXIS(axis_no)=ON        ‘start position loop servo
      NEXT axis_no
      RETURN
```

SEE ALSO:

AXIS_ENABLE, SERVO

DISPLAY

TYPE:

System Parameter

DESCRIPTION:

Determines which group of the I/O channels are to be displayed on the LCD or LED bank.

VALUE:

Controller with an LCD use the following values in **DISPLAY**

Bits 16 - 31	Bits 0 - 15	Description
	0	Inputs 0-15 (default value)
	1	Inputs 16-31
	2	Outputs 0-15 (0-7 unused on existing controllers)
	3	Outputs 16-31
1		User control of the LCD segments *
	888	Reserved value

* MC405 only. When bit 16 is set, user control of the 3x7 segment characters is enabled. By default this is disabled.

Controller with an LED display use the following values in **DISPLAY**

Bits 0 - 15	Description
0	Inputs 0-7 (default value)
1	Inputs 7-15
2	Inputs 16-23
3	Inputs 24-31
4	Outputs 0-7 (0-7 unused on existing controllers)
5	Outputs 8-15
6	Outputs 16-23
7	Outputs 24-31

EXAMPLE 1:

Show outputs 16-31 on the MC464

```
>>DISPLAY=3
>>
```

EXAMPLE 2:

Enable user control of 3x7 segments on the MC405

```
>>DISPLAY.16 = 1
```

```
    >>LCDSTR="123"
```

SEE ALSO:
`LCDSTR`

DISTRIBUTOR_KEY

TYPE:
Reserved Keyword

/ Divide

TYPE:
Mathematical operator

SYNTAX
`<expression1> / <expression2>`

DESCRIPTION:
Divides expression1 by expression2

PARAMETERS:

Expression1:	Any valid TrioBASIC expression
Expression2:	Any valid TrioBASIC expression

EXAMPLE:
Calculate a value for ‘a’ by dividing 10 by the sum of 2.1 and 9. The result is that a=0.9009

```
    a=10/(2.1+9)
```

DLINK

TYPE:
System Command

SYNTAX:

`DLINK(function,...)`

DESCRIPTION:

This is a specialised command, to allow access to the SLM™ digital drive interface. The axis parameters have to be initialised by the **`DLINK`** function 2 command before the interface can be used for controlling an external drive.

The current **`SLM`** software dictates that the drive MUST be powered up after power is applied to the *Motion Coordinator*/ **`SLM`**.

PARAMETERS:

Function:	Specifies the required function.
0	Reserved function
1	Reserved function
2	Check for presence SLM module
3	Check for presence of SLM servo drive
4	Assign a *Motion Coordinator* axis to a SLM channel
5	Read an SLM parameter
6	Write an SLM parameter
7	Write an SLM command
8	Read a drive parameter
9	Returns slot and communication channel associated with an axis
10	Read an EEPROM parameter

FUNCTION = 2:

SYNTAX:

```
value = DLINK(2, slot, com)
```

DESCRIPTION:

Check for presence SLM module on rear of motor.

PARAMETERS:

value:	Returns 1 if the SLM is answering, otherwise it returns 0.
slot:	The communications slot where the module is connected
com:	The communication channel where the axis is connected in the module

EXAMPLE

Check for a SLM module on slot 0, communication channel 0

```
    >>? DLINK(2,0,0)
    1.0000
    >>
```

FUNCTION = 3:

SYNTAX:

```
value = DLINK(3, slot, com)
```

DESCRIPTION:

Check for presence of SLM servo drive, such as MultiAx.

PARAMETERS:

value:	Returns 1 if the drive is answering, otherwise it returns 0.
slot:	The communications slot where the module is connected
com:	The communication channel where the axis is connected in the module

EXAMPLE:

Check for a SLM drive on slot 0, communication channel 0.

```
    >>? DLINK(3,0,0)
    0.0000
    >>
```

FUNCTION = 4:

SYNTAX:

```
value = DLINK(4, slot, com, axis)
```

DESCRIPTION:
Assign a *Motion Coordinator* axis to a SLM channel.

value:	Returns **TRUE** if successful otherwise returns **FALSE**
slot:	The communications slot where the module is connected
com:	The communication channel where the axis is connected in the module
axis:	The axis to be associated with this drive. If this axis is already assigned then it will fail. The **ATYPE** of this axis will be set to 11.

EXAMPLE:
Assign axis 0 to the drive connected to slot 0 and communication channel 0

```
    >>DLINK(4,0,0,0)
```

FUNCTION = 5:

SYNTAX:

```
value =  DLINK(5, axis, parameter)
```

DESCRIPTION:
Read an SLM parameter

PARAMETERS:

value:	The value returned from SLM, returns -1 if the command fails
axis:	The axis number associated with the drive
parameter:	The number of the SLM parameter to be read. This is normally in the range 0…127. See the drive documentation for further information.

EXAMPLE:
Print the value of the SLM parameter 5 from axis 0.

```
    >>PRINT DLINK(5,0,1)
    463.0000
    >>
```

FUNCTION = 6:

SYNTAX:

```
value = DLINK(6, axis, parameter, value)
```

DESCRIPTION:
Write an SLM parameter

PARAMETERS:

value:	Returns **TRUE** if successful otherwise returns **FALSE**
axis:	The axis number associated with the drive
parameter:	The number of the SLM parameter to be read. This is normally in the range 0...127. See the drive documentation for further information
value:	The value to write to the parameter

EXAMPLE:
Set SLM parameter 0 to the value 0 on axis 0.

```
    >>DLINK(6,0,0,0)
    >>
```

FUNCTION = 7:

SYNTAX:
```
value = DLINK(7, axis, command)
```

DESCRIPTION:
Write an SLM command.

PARAMETERS:

value:	Returns **TRUE** if successful otherwise returns **FALSE**
axis:	The axis number associated with the drive Function 7
command:	The command number. (See drive documentation)

EXAMPLE:
Write SLM command 250 to axis 0

```
    >>PRINT DLINK(7,0,250)
    1.0000
    >>
```

FUNCTION = 8:

SYNTAX:

```
value = DLINK(8, axis, parameter)
```

DESCRIPTION:

Read a drive parameter

PARAMETERS:

value:	The value returned from the drive, returns -1 if the command fails
axis:	The axis number associated with the drive
parameter:	The number of the drive parameter to be read. This is normally in the range 0...127. See the drive documentation for further information.

EXAMPLE:

Read drive parameter 53248 for axis 0

```
    >>PRINT DLINK(8,0,53248)
    20504.0000
    >>
```

FUNCTION = 9:

SYNTAX:

```
value = DLINK(9, axis)
```

DESCRIPTION:

Return slot and communication channel associated with an axis

PARAMETERS:

value:	10 x slot number + communication channel, returns -1 if the command fails
axis:	The axis number associated with the drive.

EXAMPLE:

Read axis 2 SLM information

```
    >>PRINT DLINK(9,2)
    >>11.0000
```

This example is for slot 1, communication channel 1

FUNCTION = 10:

SYNTAX:
`value = DLINK(10, axis, parameter)`

DESCRIPTION:
Read an EEPROM parameter

PARAMETERS:

value:	The value from the EEPROM value, returns -1 if the command fails
axis:	The axis number associated with the drive.
parameter:	EEPROM parameter number. (See drive documentation)

EXAMPLE:
Return the EEPROM parameter 29, the Flux Angle from axis 0

```
    >>PRINT DLINK(10,0,29)
    >>62128.0000
```

$ Dollar

TYPE:
Special Character

SYNTAX
`$number`

DESCRIPTION:
The $ symbol is used to specify that the following signed 53bit number is in hexadecimal format.

EXAMPLES:

EXAMPLE 1:
Store the hexadecimal value of 38F3B into **VR** 10 and –A58 into **VR** 11

```
    VR(10)=$38F3B
    VR(11)=-$A58
```

EXAMPLE 2:
Turn on outputs 11,12,15,16

```
    OP($CC00)
```

DPOS

TYPE:
Axis Parameter (Read Only)

DESCRIPTION:
The demand position **DPOS** is the demanded axis position generated by the motion commands.

DPOS is set to **MPOS** when **SERVO** or **WDOG** are OFF

DPOS can be adjusted without any motion by using **DEFPOS** or **OFFPOS**.

A step change in **DPOS** can be written using **ENDMOVE**

VALUE:
Demand position in user units. Default 0 on power up.

EXAMPLE:
Return the demand position for axis 10 in user units

```
    >>? DPOS AXIS(10)
    5432
    >>
```

SEE ALSO:
DEFPOS, ENDMOVE, OFFPOS, AXIS_DPOS

DRIVE_CLEAR

TYPE:
Axis Function

SYNTAX:
value = DRIVE_CLEAR(parameter)

DESCRIPTION:
DRIVE_CLEAR allows the user to clear alarms in the drive. Currently this is only supports Panasonic A4N and A5N drives.

DRIVE_READ can be used to read the value of the alarm

PARAMETERS:

parameter:	0	Clear current alarm
	1	Clear all alarm history
	2	Clear all external alarms

SEE ALSO:

`DRIVE_READ`

DRIVE_CONTROL

TYPE:

Reserved Keyword

SEE ALSO:

`DRIVE_READ, DRIVE_WRITE`

DRIVE_CONTROLWORD

TYPE:

Axis Parameter

DESCRIPTION:

Sets the Control Word which is sent cyclically to a remote drive connected by a fieldbus. For example in CANopen over EtherCAT (CoE) the **`DRIVE_CONTROLWORD`** would set the value in object $6040 sub-index $00.

VALUE:

Example for a CANopen over EtherCAT (CoE) remote drive. See specific drive manuals for further details.

Bit	Description
0	Switch on
1	Enable voltage
2	Quick stop
3	Enable operation
4	Homing operation start

Bit	Description
5	Operation mode specific
6	Operation mode specific
7	Fault reset
8	Halt

EXAMPLE:

Write to the CoE control word sent cyclically to the drive connected as axis 6 on an EtherCAT network.

```
    BASE(6)
    DRIVE_CW_MODE=1 ‘ take manual control of the Control Word
    DRIVE_CONTROLWORD = $2F ‘ set the bits to enable the drive
```

DRIVE_CW_MODE

TYPE:

Axis Parameter

DESCRIPTION:

The operation of the control word sent cyclically to a remote drive is, by default, controlled by the firmware. For example the control word will usually be under the control of the **WDOG** and **AXIS_ENABLE** parameters so that the drive can be enabled and disabled by software. Optionally, if **DRIVE_CW_MODE** is set to non-zero, the control word may be set by a user program.

VALUE:

The mode of operation for the drive control word.

0	System sets the value of the control word, depending on state of **WDOG** and **AXIS_ENABLE**. [default]
1	User program takes control of the control word via **DRIVE_CONTROLWORD**.
2	User program takes control of bits 11 to 15 via **DRIVE_CONTROLWORD**. Allows manufacturer specific bits to be changed while the enable bits are under control of **WDOG** and **AXIS_ENABLE**.

EXAMPLE:

EXAMPLE1

Take over the CoE control word sent cyclically to the drive connected as axis 0 on an EtherCAT network. Then toggle the reset bit.

```
    BASE(0)
    DRIVE_CW_MODE=1 ‘ take manual control of the Control Word
    DRIVE_CONTROLWORD = $06 ‘ disable the drive
    WA(10)
    DRIVE_CONTROLWORD = $86 ‘ reset the drive
    WA(10)
    DRIVE_CONTROLWORD = $06
```

EXAMPLE2

Take over the CoE control word sent cyclically to the drive connected as axis 2 on an EtherCAT network. Then make a sequence to start homing.

```
      BASE(2)
      SERVO=OFF
      DRIVE_CW_MODE=1 ‘ set the control word to be user mode
      DRIVE_CONTROLWORD=$06 ‘ disable the drive
      ‘ Set the drive to DS402 homing mode
      CO_WRITE_AXIS(ax,$6060,$00,2,-1,6)
      ‘ wait for the homing mode to be accepted
      VR(100)=0
      REPEAT
        CO_READ_AXIS(ax,$6061,$00,2,100)
      UNTIL VR(100)=6

    ‘ set the homing method (1 for +ve direction, 2 for -ve)
      fwd=1
      rev=2
      CO_WRITE_AXIS(ax,$6098,$00,2,-1,fwd)

      DRIVE_CONTROLWORD=$1f ‘start homing
      WA(20)

      ‘ wait for Homing Done flag (bit 12)
      REPEAT
        WA(1)
      UNTIL DRIVE_STATUS.12=1
      WA(20)
      DEFPOS(ENCODER) ‘ set the axis position to drive’s value
      SERVO=ON
      WDOG=ON
      ‘ Set the drive to position mode
      CO_WRITE_AXIS(ax,$6060,$00,2,-1,8)
      ‘ Set control word to normal enabled state
      DRIVE_CONTROLWORD=$2f
      DRIVE_CW_MODE=0 ‘ set the control word back to wdog mode
```

DRIVE_FE

TYPE:
Axis Parameter

DESCRIPTION:
Returns the value of following error calculated by a remote drive in position mode. For this value to be active, the cyclic data transfer from the drive must be first configured to return the drive actual position error value. For a drive connected by CanOpen over EtherCAT (CoE) the value will be configured as part of the Process Data Object. (PDO)

VALUE:
The drive position error returned in drive units.

EXAMPLE:

EXAMPLE1
Display the drive's position error to *Motion* Perfect terminal 5.

```
PRINT #5,"Drive Position Error = ";DRIVE_FE AXIS(3)
```

EXAMPLE2
Wait for the drive's position error to go below a pre-defined threshold value.

```
BASE(2)
WAIT UNTIL ABS(DRIVE_FE) < 300
```

DRIVE_FE_LIMIT

TYPE:
Axis Parameter

ALTERNATE FORMAT:
None

DESCRIPTION:
This is the maximum allowable following error applied to the **DRIVE_FE** value. i.e. the actual following error in a remote drive which is received via a fieldbus such as EtherCAT. When exceeded the controller will generate an **AXISSTATUS** error, by default this will also generate a **MOTION_ERROR**. The **MOTION_ERROR** will disable the **WDOG** relay thus stopping further motor operation.

This limit may be used to guard against fault conditions such as mechanical lock-up, loss of encoder feedback, etc.

When either **DRIVE_FE_LIMIT** or **FE_LIMIT** are exceeded, bit 8 of **AXISSTATUS** is set.

VALUE:
The maximum allowable following error in user units. The default value is 20000 encoder edges.

EXAMPLE:
Initialise the axis as part of a **STARTUP** routine. **FE_LIMIT** is set larger than **DRIVE_FE_LIMIT** because the internal calculated FE is usually bigger than the following error calculated within the remote drive.

```
FOR x = 0 to 4
  BASE(x)
  UNITS = 100
  FE_LIMIT = 50
  DRIVE_FE_LIMIT = 10
  SPEED = 100
  ACCEL=1000
  DECEL=ACCEL
NEXT x
```

SEE ALSO:
FE, FE_LIMIT, DRIVE_FE

DRIVE_INDEX

TYPE:
Axis Parameter

SYNTAX:
DRIVE_INDEX AXIS(n) = value

DESCRIPTION:

DRIVE_INDEX is used to map additional **PDO** parameters in the EtherCAT servo drive into **VR** variables. The value given is the base **VR** address for the mapping. The non-standard **PDO** parameters are mapped one per **VR**, starting with the first **PDO** parameter following the standard objects.

This axis parameter can be added to the **MC_CONFIG**.

The EtherCAT drive must be configured with an application specific profile before this function can be used.

PARAMETERS:

value:	The **VR** index where incoming PDO data will be mapped

EXAMPLES:

EXAMPLE 1:

Transfer application data to and from the drive cyclically in the PDO telegram. The EtherCAT axis is pre-configured for special application software to run in the drive.

```
    DRIVE_INDEX = 100
    ' Get incoming cyclic data
    user_status_1 = VR(100)
    user_status_2 = VR(101)
    ' Set outgoing data
    VR(102) = user_control_word
    VR(103) = winder_mode
    VR(104) = ref_value_1
    VR(105) = ref_value_2
    VR(106) = correction_value
    VR(107) = program_state
```

DRIVE_MODE

TYPE:

Axis Parameter (**MC_CONFIG**)

SYNTAX:

DRIVE_MODE AXIS(n) = value

DESCRIPTION:

DRIVE_MODE sets the mode of operation to be used by a remote drive over EtherCAT. This **MUST** be set in **MC_CONFIG** if the EtherCAT is to be initialised on power up in the required mode. **DRIVE_MODE** automatically sets the drive's mode of operation and the axis **ATYPE**.

This axis parameter can be added to the **MC_CONFIG**.

PARAMETERS:

value:	1 : Cyclic Synchronous Position mode (CSP) 2 : Cyclic Synchronous Velocity mode (CSV) 3: Cyclic Synchronous Torque mode (CST)

EXAMPLES:

EXAMPLE 1:

Four EtherCAT axes are to be set up, 2 axes in position mode, 1 axis in velocity mode and 1 axis in torque mode. Note that the *Motion Coordinator* can close the position loop when the drive is in CSV or CST mode, or the axis can be operated open-loop.

```
 ` setup 4 axes in MC_CONFIG
 ` Note: ATYPE is set automatically, do not set in MC_CONFIG
DRIVE_MODE AXIS(0)=1 ` position mode
DRIVE_MODE AXIS(1)=1 ` position mode
DRIVE_MODE AXIS(2)=2 ` velocity mode
DRIVE_MODE AXIS(3)=3 ` torque mode
```

SEE ALSO:

DRIVE_PROFILE

DRIVE_PARAMETER

TYPE:

Reserved Keyword

SEE ALSO:

DRIVE_READ, DRIVE_WRITE

DRIVE_PROFILE

TYPE:

Axis Parameter (**MC_CONFIG**)

SYNTAX:

DRIVE_PROFILE AXIS(n) = value

DESCRIPTION:

DRIVE_PROFILE allows the selection of different EtherCAT profiles from the internal database to be used with a remote drive over EtherCAT. This **MUST** be set in **MC_CONFIG** if the EtherCAT is to be initialised on power up with the required profile.

This axis parameter can be added to the **MC_CONFIG**.

The EtherCAT drive must have an application specific profile within the *Motion Coordinator*'s internal database before this function can be used.

PARAMETERS:

value:	0 :	Use the default "standard profile" with minimum objects passed between drive and *Motion Coordinator*.
	1 - n :	Use the application profile numbered.

EXAMPLES:

EXAMPLE 1:

Set up 4 axes to use application profiles for the cyclic PDO telegram. The EtherCAT axis profiles can be examined with the **ETHERCAT**($116, vendor_ID) command.

In the *Motion* Perfect terminal command line enter **ETHERCAT**($120) to see a list of **VENDOR** IDs.

```
    ETHERCAT($120)
    Kollmorgen (0x0000006A)
```

Next enter **ETHERCAT**($116, vendor_id)

```
    ETHERCAT($116,$6a)
    Kollmorgen (0x0000006A), AKD (0x00414B44), 65, (0)
    Kollmorgen (0x0000006A), AKD (0x00414B44), 65, (1)
    Kollmorgen (0x0000006A), AKD (0x00414B44), 65, (2)
    etc.
```

The number in parentheses is the profile number. The profile PDO details will also be listed. 65 is the **ATYPE**, in this case EtherCAT velocity control.

In **MC_CONFIG**, put the required profile number for each axis.

```
    DRIVE_PROFILE AXIS(0)=2
    DRIVE_PROFILE AXIS(1)=2
    DRIVE_PROFILE AXIS(2)=2
    DRIVE_PROFILE AXIS(3)=1
```

SEE ALSO:

DRIVE_MODE

DRIVE_READ

TYPE:
Axis Function

SYNTAX:
value = DRIVE_READ(parameter [,vr_index])

DESCRIPTION:
DRIVE_READ allows the controller to read a parameter from a digital bus connected drive. Currently this is only supports Panasonic A4N and A5N drives.

The parameter index and details can be found in the *Motion* Perfect intelligent drives tool.

PARAMETERS:

	Value	Description
value:	1	**DRIVE_READ** was successful
	0	**DRIVE_READ** failed
	If vr_index is not used the return value is the parameter value	
parameter:	parameter_number	A4N parameter number to read
	(class * 256) + parameter_number or (class * $100) + parameter_number	A5N parameter number to read
	65536 + SSID_code or $10000 + SSID_code	Read a System ID into a **VRSTRING**
	131072 + (alarm_index * 4096) + alarm_function or $20000 + (alarm_index * $1000) + alarm_function	Read an Alarm code
	196608 + (index * 4096) + monitor_number or $30000 + (index * $1000) + monitor_number	Read a Monitor Value
vr_index:	VR in which to store the returned value	

System ID, Alarm codes and Monitor Commands apply to both A4N and A5N drives.

SYSTEM STRING ID CODES

SSID_code	Description
$010	Drive Vendor
$120	Drive Model No.
$130	Drive Serial No.
$140	Drive Firmware Version
$220	Motor Model No.
$230	Motor Serial No.
$310	External Scale Vendor
$320	External Scale Model No.

ALARM FUNCTIONS

Alarm Code	Description	Index
$000	Alarm Read	Index of alarm to be read
$001	Clear Current Alarm	0
$011	Clear All Alarms	0
$012	Clear External Alarm	0

DRIVE_CLEAR can be used to clear alarms

EXAMPLES:

EXAMPLE 1:

Read parameter 124, external scale direction from a A4N drive

```
success = DRIVE_READ(124,0)
IF success = 0 THEN
  PRINT “Error reading drive parameter”
ELSE
  PRINT “External scale direction = “; VR(0)[0]
ENDIF
```

EXAMPLE 2:

Read class 3 parameter 26, external scale direction from a A5N drive

```
success = DRIVE_READ(3 * 256 + 26,0)
IF success = 0 THEN
  PRINT "Error reading drive parameter"
ELSE
  PRINT "External scale direction = "; VR(0)[0]
ENDIF
```

EXAMPLE 3:

Read the system ID to find the Panasonic servo drive serial number into a **VRSTRING** starting at **VR**(0).

```
success = DRIVE_READ($10000 + $130,0)
IF success = 0 THEN
  PRINT "Error reading drive parameter"
ELSE
  PRINT "Driver Serial No. = ";VRSTRING(0)
ENDIF
```

EXAMPLE 4:

Read the alarm history from the Panasonic servo drive.

```
PRINT "Alarm Read AXIS(";axis_no[0];")"
FOR past_alarm = 0 TO 14
  DRIVE_READ($20000 + past_alarm * 4096 + 0 ,0)
  PRINT "Alarm history index "; past_alarm[0];" = ";VR(0)[0]
NEXT past_alarm
```

EXAMPLE 5:

Read monitor type code 102 to find the encoder resolution of a Panasonic servo drive.

```
success = DRIVE_READ($30000 + $102, 0)
IF success = FALSE THEN
  PRINT "Error reading drive parameter"
ELSE
  PRINT "Encoder resolution = ";VR(0)[0]
ENDIF
```

EXAMPLE 6:

The following routine can be used to home to the Z mark on the motor encoder using an A4N.This works by waiting for the Z mark o be seen on the drive then reading the mechanical angle.

```
pos = DRIVE_READ($30201)
oneturn=10000' Distance for one turn depends on encoder type

IF pos <> -1 THEN
  PRINT "Mechanical offset:";pos[0]
```

```
    ELSE
      PRINT “Drive has not yet seen Z mark”
      MOVE(oneturn)
      WAIT UNTIL DRIVE_READ($30201)<>-1
      CANCEL
      WAIT IDLE
      pos = DRIVE_READ($30201)
      PRINT “Mechanical offset:”;pos[0]
    ENDIF
    DEFPOS(pos)
```

DRIVE_SET_VAL

TYPE:
Reserved Keyword

SEE ALSO:
DRIVE_READ, **DRIVE_WRITE**

DRIVE_STATUS

TYPE:
Axis Parameter

DESCRIPTION:
Returns the Status Word received cyclically from a remote drive connected by a fieldbus. For example in CANopen over EtherCAT (CoE) the **DRIVE_STATUS** would have the value from object $6041 sub-index $00.

VALUE:
Example for a CANopen over EtherCAT (CoE) remote drive. See specific drive manuals for further details.

Bit	Description
0	Ready to switch on
1	Switched on
2	Operation enabled
3	Fault

4	Voltage enabled
5	quick stop
6	switch on disabled
7	warning

EXAMPLE:

Read the CoE status from the drive connect as axis 4 on an EtherCAT network.

```
    PRINT #5,HEX(DRIVE_STATUS AXIS(4))
```

DRIVE_TORQUE

TYPE:

Axis Parameter

DESCRIPTION:

Returns the actual torque value calculated by a remote drive. For this value to be active, the cyclic data transfer from the drive must be first configured to return the drive actual torque value. For a drive connected by CanOpen over EtherCAT (CoE) the value will be configured as part of the Process Data Object. (PDO)

VALUE:

The drive torque returned in drive units.

EXAMPLE:

EXAMPLE1

Display the drive's torque to *Motion* Perfect terminal 5.

```
    PRINT #5,"Drive torque value = ";DRIVE_TORQUE AXIS(2)
```

EXAMPLE2

Wait for the drive's torque value to go below a pre-defined level.

```
    BASE(16)
    WAIT UNTIL DRIVE_TORQUE < 3000
```

DRIVE_VALUE

TYPE:
Reserved Keyword

SEE ALSO:
`DRIVE_READ`, `DRIVE_WRITE`

DRIVE_WRITE

TYPE:
Axis Function

SYNTAX:
`result = DRIVE_WRITE (parameter, value)`

DESCRIPTION:
`DRIVE_WRITE` allows the controller to write to a parameter from a digital bus connected drive. Currently this is only supports Panasonic A4N and A5N drives.

The parameter numbers and details can be found in the *Motion* Perfect intelligent drives tool.

PARAMETERS:

result:	1	`DRIVE_WRITE` was successful
	0	`DRIVE_WRITE` failed
parameter:	parameter_number	A4N parameter to write
	class * 256 + parameter_number	A5N parameter to write
	128	Stores all drive parameters into EPROM
	129	Resets all drive parameters to default values
value:		The value to be written to the parameter. (Use 0 for parameter numbers 128 & 129)

EXAMPLES:

EXAMPLE 1:

Write parameter 122, encoder scale on an A4N drive

```
success = DRIVE_WRITE(122, 10000)
If success = 0 THEN
  PRINT “Error writing drive parameter”
ELSE
  PRINT “Encoder scale set”
ENDIF
```

EXAMPLE 2:

Write class 0 parameter 8, encoder scale on an A5N drive

```
success = DRIVE_WRITE(0 * 256 + 8, 15000)
If success = 0 THEN
  PRINT “Error writing drive parameter”
ELSE
  PRINT “Encoder scale set”
ENDIF
```

EXAMPLE 3:

Store all drive parameters in EPROM

```
success = DRIVE_WRITE(128, 0)
IF success = 0 THEN
  PRINT “Error storing drive parameters to EPROM”
ELSE
  PRINT “Drive parameters stored in EPROM”
ENDIF
```

EXAMPLE 4:

Reset all drive parameters to default values

```
success = DRIVE_WRITE(129, 0)
IF success = 0 THEN
  PRINT “Error resetting drive parameters”
ELSE
  PRINT “Drive parameters reset to defaults”
ENDIF
```

DRIVEIO_BASE

TYPE:
System Parameter (**`MC_CONFIG`**)

DESCRIPTION:
This parameter sets the start address of any drive I/O channels. Together with **`CANIO_BASE`**, **`MODULEIO_BASE`** and **`NODE_IO`** the I/O allocation scheme can replace and expand the behaviour of **`MODULE_IO_MODE`**.

VALUE:

-1	Drive I/O disabled (default)
0	Drive I/O allocated automatically
>= 8	Drive I/O is located at this IO point address, truncated to the nearest multiple of 8

EXAMPLE:
A system with MC464, a Panasonic module (slot 0) and a **`CANIO`** Module will have the following I/O assignment:

`DRIVEIO_BASE`=0 + **`MODULEIO_BASE`**=0 + **`CANIO_BASE`**=0

0-7	Built in inputs
8-15	Built in bi-directional I/O
16-23	Panasonic module inputs
24-39	**`CANIO`** bi-directional I/O
40-47	Panasonic drive inputs
48-1023	Virtual I/O

`DRIVEIO_BASE`=-1 + **`MODULEIO_BASE`**=0 + **`CANIO_BASE`**=0

0-7	Built in inputs
8-15	Built in bi-directional I/O
16-23	Panasonic module inputs
24-39	**`CANIO`** bi-directional I/O
40-1023	Virtual I/O

DRIVEIO_BASE=200 + **MODULEIO_BASE**=80 + **CANIO_BASE**=400

0-7	Built in inputs
8-15	Built in bi-directional I/O
16-79	Virtual I/O
80-87	Panasonic module inputs
88-199	Virtual I/O
200-207	Panasonic drive inputs
208-399	Virtual I/O
400-415	**CANIO** bi-directional I/O
416-1023	Virtual I/O

SEE ALSO:
CANIO_BASE, MODULEIO_BASE, NODE_IO, MODULE_IO_MODE

DUMP

TYPE:
Reserved Keyword

EDPROG

TYPE:
System Command

SYNTAX:
`EDPROG [parameters,] function`

ALTERNATE FORMAT:
`& function[, parameters]`

DESCRIPTION:
This is a special command that may be used to manipulate the `SELECTed` programs on the controller.

It is not normally used except by *Motion* Perfect.

FUNCTIONS:

1	I	Insert string
2	S	Search for string
3	D	Delete line
4	L	Print lines
5	N	Print number of lines
6	A	Print label addresses
7	C	Prints the name of the currently selected program
8	R	Replace line
9	K	Print checksum
10	Z	Print checksum of specified program
11	X	Print object code checksum
12	Q	Checks if the controller directory is corrupt
13	V	Print variable list
14	M	Commit changes

FUNCTION = A:

SYNTAX:

```
EDPROG 6, to_line, from_line
```

ALTERNATE SYNTAX:

```
& from_line, to_line A
```

DESCRIPTION:

Prints all label names in the region defined in the **SELECTed** program.

PARAMETERS:

from_line:	The first line of the **SELECTed** program to search
to_line:	The last line of the **SELECTed** program to search

FUNCTION = C:

SYNTAX:

```
EDPROG C
```

ALTERNATE SYNTAX:

```
& C
```

DESCRIPTION:

Prints the name of the currently **SELECTed** program.

FUNCTION = D:

SYNTAX:

```
EDPROG 3, line_no
```

ALTERNATE SYNTAX:

```
& line_no D
```

DESCRIPTION:

Deletes the specified line

PARAMETER:

line_no:	Any valid line number form the **SELECTed** program

FUNCTION = I:

SYNTAX:
EDPROG string, 1, line_no

ALTERNATE SYNTAX:
& line_no I,string

DESCRIPTION:
Insert the text string in the currently selected program at the specified line.

You should **NOT** enclose the string in quotes unless they need to be inserted into the program.

PARAMETERS:

line_no:	The line to insert the string
string:	The text string to insert into the **SELECTed** program

FUNCTION = K:

SYNTAX:
EDPROG 10

ALTERNATE SYNTAX:
& K

DESCRIPTION:
Print the checksum of the system software

FUNCTION = L:

SYNTAX:
EDPROG 4, end, start

ALTERNATE SYNTAX:
`& start, end L`

DESCRIPTION:
Print the lines of the currently selected program between start and end

PARAMETERS:

start:	The first line to print from the **`SELECTed`** program
end:	The last line to print from the **`SELECTed`** program

FUNCTION = M:

SYNTAX:
`EDPROG 14`

ALTERNATE SYNTAX:
`& M`

DESCRIPTION:
Saves all program changes to flash.

FUNCTION N:

SYNTAX:
`EDPROG 5`

ALTERNATE SYNTAX:
`& N`

DESCRIPTION:
Print the number of lines in the currently **`SELECTed`** program

FUNCTION = Q:

SYNTAX:
`EDPROG 12`

ALTERNATE SYNTAX:
`& Q`

DESCRIPTION:
Returns the state of the controllers program memory.

RETURN VALUE:

0	Controller memory OK
1	Controller memory corrupted

FUNCTION = R:

SYNTAX:
`EDPROG string, 8, line`

ALTERNATE SYNTAX:
`& line R, string`

DESCRIPTION:
Replace the line <line> in the currently **SELECTed** program with the text <string>.

You should **NOT** enclose the string in quotes unless they need to be inserted into the program.

PARAMETERS:

line_no:	The line to replace
string:	The text string to replace the line in the **SELECTed** program

FUNCTION = S:

SYNTAX:
`EDPROG string, 2, to_line, from_line`

ALTERNATE SYNTAX:
`& from_line, to_line S string`

DESCRIPTION:
Prints the line number of the first occurrence of the string in the region defined in the **SELECTed** program.

PARAMETERS:

from_line:	The first line of the **SELECTed** program to search
to_line:	The last line of the **SELECTed** program to search
string	The string to search for

FUNCTION = V:

SYNTAX:
```
EDPROG 13
```

ALTERNATE SYNTAX:
```
& V
```

DESCRIPTION:
Print all variables defined in the **SELECTed** program.

FUNCTION = X:

SYNTAX:
```
EDPROG 11
```

ALTERNATE SYNTAX:
```
& X
```

DESCRIPTION:
Print the 16bit CRC checksum of the **SELECTed** program.

FUNCTION = Z:

SYNTAX:
```
EDPROG progname, 10
```

ALTERNATE SYNTAX:
```
& Z, progname
```

DESCRIPTION:
Print the CRC checksum of the specified program.

RETURN VALUE:

Returns the checksum using standard **CCITT** 16 bit generator polynomial.

SEE ALSO:

SELECT

EDPROG1

TYPE:

System Command

SYNTAX:

EDPROG1 prog_name,[parameters,] function

ALTERNATE FORMAT:

! prog_name, prog_name, function[, parameters]

DESCRIPTION:

This is a special command that may be used to manipulate the **SELECTed** programs on the controller.

It is not normally used except by *Motion* Perfect.

FUNCTIONS:

1	I	Insert string
2	S	Search for string
3	D	Delete line
4	L	Print lines
5	N	Print number of lines
6	A	Print label addresses
7	C	Prints the name of the currently selected program
8	R	Replace line
9	K	Print checksum
10	Z	Print checksum of specified program

11	X	Print object code checksum
12	Q	Checks if the controller directory is corrupt
13	V	Print variable list
14	M	Commit changes

FUNCTION = A:

SYNTAX:
`EDPROG16, to_line, from_line`

ALTERNATE SYNTAX:
`! prog_name, from_line, to_line A`

DESCRIPTION:
Prints all label names in the region defined in the **SELECTed** program.

PARAMETERS:

from_line:	The first line of the **SELECTed** program to search
to_line:	The last line of the **SELECTed** program to search

FUNCTION = C:

SYNTAX:
`EDPROG1C`

ALTERNATE SYNTAX:
`! prog_name, C`

DESCRIPTION:
Prints the name of the currently **SELECTed** program.

FUNCTION = D:

SYNTAX:
`EDPROG1 prog_name, 3, line_no`

ALTERNATE SYNTAX:

```
! prog_name, line_no D
```

DESCRIPTION:

Deletes the specified line

PARAMETER:

line_no:	Any valid line number form the **SELECTed** program

FUNCTION = I:

SYNTAX:

```
EDPROG1 prog_name, string, 1, line_no
```

ALTERNATE SYNTAX:

```
! prog_name, line_no I,string
```

DESCRIPTION:

Insert the text string in the currently selected program at the specified line.

You should **NOT** enclose the string in quotes unless they need to be inserted into the program.

PARAMETERS:

line_no:	The line to insert the string
string:	The text string to insert into the **SELECTed** program

---

FUNCTION = K:

SYNTAX:

```
EDPROG1 prog_name, 10
```

ALTERNATE SYNTAX:

```
! prog_name, K
```

DESCRIPTION:

Print the checksum of the system software

FUNCTION = L:

SYNTAX:
```
EDPROG1 prog_name, 4, end, start
```

ALTERNATE SYNTAX:
```
! prog_name, start, end L
```

DESCRIPTION:
Print the lines of the currently selected program between start and end

PARAMETERS:

start:	The first line to print from the **SELECTed** program
end:	The last line to print from the **SELECTed** program

FUNCTION = M:

SYNTAX:
```
EDPROG1 prog_name, 14
```

ALTERNATE SYNTAX:
```
! prog_name, M
```

DESCRIPTION:
Saves all program changes to flash.

FUNCTION N:

SYNTAX:
```
EDPROG1 prog_name, 5
```

ALTERNATE SYNTAX:
```
! prog_name, N
```

DESCRIPTION:
Print the number of lines in the currently **SELECTed** program

FUNCTION = Q:

SYNTAX:

`EDPROG1 prog_name, 12`

ALTERNATE SYNTAX:

`! prog_name, Q`

DESCRIPTION:

Returns the state of the controllers program memory.

RETURN VALUE:

0	Controller memory OK
1	Controller memory corrupted

FUNCTION = R:

SYNTAX:

`EDPROG1 prog_name, string, 8, line`

ALTERNATE SYNTAX:

`! prog_name, line R, string`

DESCRIPTION:

Replace the line <line> in the currently **SELECTed** program with the text <string>.

You should **NOT** enclose the string in quotes unless they need to be inserted into the program.

PARAMETERS:

line_no:	The line to replace
string:	The text string to replace the line in the **SELECTed** program

FUNCTION = S:

SYNTAX:

`EDPROG1 prog_name, string, 2, to_line, from_line`

ALTERNATE SYNTAX:

`! prog_name, from_line, to_line S string`

DESCRIPTION:
Prints the line number of the first occurrence of the string in the region defined in the **`SELECTed`** program.

PARAMETERS:

from_line:	The first line of the **`SELECTed`** program to search
to_line:	The last line of the **`SELECTed`** program to search
string	The string to search for

FUNCTION = V:

SYNTAX:
```
EDPROG1 prog_name, 13
```

ALTERNATE SYNTAX:
```
! prog_name, V
```

DESCRIPTION:
Print all variables defined in the **`SELECTed`** program.

FUNCTION = X:

SYNTAX:
```
EDPROG1 prog_name, 11
```

ALTERNATE SYNTAX:
```
! prog_name, X
```

DESCRIPTION:
Print the 16bit CRC checksum of the **`SELECTed`** program.

FUNCTION = Z:

SYNTAX:
```
EDPROG1 prog_name, progname, 10
```

ALTERNATE SYNTAX:
```
! prog_name, Z, progname
```

DESCRIPTION:
Print the CRC checksum of the specified program.

RETURN VALUE:
Returns the checksum using standard **CCITT** 16 bit generator polynomial.

SEE ALSO:
SELECT

ENCODER

TYPE:
Axis Parameter (Read Only)

DESCRIPTION:
The **ENCODER** axis parameter holds a raw copy of the positional feedback device.

The **MPOS** axis measured position is calculated from the **ENCODER** value automatically allowing for overflows and offsets.

VALUE:

Feedback device	Value
Incremental encoder:	The value latched in the encoder hardware register
Absolute Encoder:	The positional value using the number of bits set in **ENCODER_BITS**
Digital Axis:	Raw position feedback from the drive

EE ALSO:
ENCODER_BITS, MPOS

ENCODER_BITS

TYPE:
Axis Parameter (**MC_CONFIG**)

DESCRIPTION:
This parameter is only used with an absolute encoder axis. It is used to set the number of data bits to be clocked out of the encoder by the axis hardware. There are 2 types of absolute encoder supported by this

parameter; SSI and EnDat.

If the number of **ENCODER_BITS** is to be changed, the parameter must first be set to zero before entering the new value.

ENCODER_BITS must be set before the **ATYPE** is set

VALUE:

Encoder type	Bits	Value	Function
All:	0	0	No data is clocked out of the encoder (default)
SSI:	Bit 0-5	0-32	The number of bits to be clocked out of the encoder.
	Bit 6	64	Set for Binary, clear for Gray code (default)
	Bit 7	128	Reverses direction (inverts the data bits)
EnDat:	Bits 0..7	0-255	The total number of data bits returned
	Bits 8..13	256-8192	The number of multi-turn bits
	Bit 14	16384	This is set by the controller when a correct CRC is calculated from the encoder position data.

EXAMPLES:

EXAMPLE 1:

Set up 2 axes of SSI absolute encoder

```
ENCODER_BITS AXIS(3) = 12
ENCODER_BITS AXIS(7) = 21
```

EXAMPLE 2:

Re-initialise **MPOS** using absolute value from encoder

```
SERVO=OFF
ENCODER_BITS = 0
ENCODER_BITS = databits
```

EXAMPLE 3:

A 25 bit EnDat encoder has 12 multi-turn and 13 bits/turn resolution. (Total number of bits is 25)

```
ENCODER_BITS = 25 + (256 * 12)
ATYPE = 47
```

SEE ALSO:
ATYPE, ENCODER_CONTROL, ENCODER_READ, ENCODER_WRITE

ENCODER_CONTROL

TYPE:
Axis Parameter

DESCRIPTION:
Endat encoders can be set to either cyclically return their position, or they can be set to a parameter read/ write mode.

Using the **ENCODER_READ** or **ENCODER_WRITE** functions will set the parameter to 1 automatically.

VALUE:

0	position return mode (default value)
1	sets parameter read/write mode

EXAMPLE:
Reset **ENCODER_CONTROL** after an **ENCODER_READ** so that the position is returned.

```
    value = ENCODER_READ($A700)
    ENCODER_CONTROL = 0
```

SEE ALSO:
ENCODER_READ, ENCODER_WRITE

ENCODER_FILTER

TYPE:
Axis Parameter

DESCRIPTION:
This parameter allows filtering to be applied to an encoder feedback to reduce the impact of jitter. The smaller the value the larger the time constant and so the less impact jitter will have on the system.

This parameter can be used to reduce jitter on a master axis which is linked to another axis.

VALUE:
Filter parameter range 0.001 to 1 (default 1).

EXAMPLE:
Apply a filter to a line encoder so that the connected axes are not affected by any jitter:

```
BASE(0)
ENCODER_FILTER= 0.95
BASE(1)
CONNECT(1,0)
```

ENCODER_ID

TYPE:
Axis Parameter

DESCRIPTION:
This parameter returns the Encoder Identification (**ENID**) parameter from a Tamagawa absolute encoder.

VALUE:
Only encoders returning 17 are currently supported

EXAMPLE:
Initialise a Tamagawa absolute encoder and check it is working by looking at **ENCODER_ID**.

```
ATYPE = 46
IF ENCODER_ID<>17 THEN
  PRINT#term, “Incorrect ENID”
ENDIF
```

ENCODER_RATIO

TYPE:
Axis Command

SYNTAX:
ENCODER_RATIO(mpos_count, input_count)

DESCRIPTION:
This command allows the incoming encoder count to be scaled by a non integer ratio:

MPOS = (mpos_count / input_count) x encoder_edges_input

When using the servo loop you will need to adjust the gains to maintain performance and stability.

Unlike the **UNITS** parameter, which only affects the scaling seen by the user programs, **ENCODER_RATIO** affects all motion commands.

ENCODER_RATIO does not replace **UNITS**. Only use **ENCODER_RATIO** where absolutely necessary. **PP_STEP** and **ENCODER_RATIO** cannot be used at the same time on the same axis.

PARAMETERS:

mpos_count:	An integer number which defines the numerator
input_count:	An integer number which defines the denominator

Large ratios should be avoided as they will lead to either loss of resolution or much reduced smoothness in the motion. The actual physical encoder count is the basic resolution of the axis and use of this command may reduce the ability of the *Motion Coordinator* to accurately achieve all positions.

EXAMPLES:

EXAMPLE 1:

A rotary table has a servo motor connected directly to its centre of rotation. An encoder is mounted to the rear of the servo motor and returns a value of 8192 counts per rev. The application requires the table to be calibrated in degrees so that each degree is an integer number of counts.

As 8192 cannot be exactly divided into 360 **ENCODER_RATIO** is used to adjust the encoder feedback.

The highest value that is less than 8192 yet divides into 360 should be chosen. This is 7200 (7200 / 20 = 360). This reduces the resolution from 0.044 to 0.055 degrees, but enables you to program easily in degrees.

```
ENCODER_RATIO(7200,8192)
UNITS = 20 ‘ axis calibrated in degrees
```

EXAMPLE 2:

An X-Y system has 2 different gearboxes on its vertical and horizontal axes. The software needs to use interpolated moves, including **MOVECIRC** and **MUST** therefore have **UNITS** on the 2 axes set the same. Axis 3 (X) is 409 counts per mm and axis 4 (Y) has 560 counts per mm. So as to use the maximum resolution available, set both axes to be 560 counts per mm with the **ENCODER_RATIO** command.

```
ENCODER_RATIO(560,409) AXIS(3) ‘axis 3 is now 560 counts/mm
UNITS AXIS(3) = 56 ‘X axis calibrated in mm x 10
UNTIS AXIS(4) = 56 ‘Y axis calibrated in mm x 10
MOVECIRC(200,100,100,0,1) ‘move axes in a semicircle
```

EXAMPLE 3:

Set up an axis to work in the reverse direction. For a servo axis, both the **ENCODER_RATIO** and the **DAC_SCALE** must be set to minus values.

```
BASE(5) ‘ set axis 5 to work in reverse direction
```

```
    DAC_SCALE = -1
    ENCODER_RATIO(-1,1)
```

EXAMPLE 4:

Set up a digital position control axis, for example EtherCAT Position, to work in the reverse direction. For an axis where the servo-drive closes the position loop, both the **ENCODER_RATIO** and the **STEP_RATIO** must be set to minus values.

```
    BASE(30) ‘ set axis 30 to work in reverse direction
    ENCODER_RATIO(-1,1)
    STEP_RATIO(-1,1)
```

SEE ALSO:

STEP_RATIO, DAC_SCALE

ENCODER_READ

TYPE:

Axis Function

SYNTAX:

value = ENCODER_READ (address)

DESCRIPTION:

Read an internal register from an EnDat absolute encoder.

PARAMETERS:

value:	Value returned from the specified register. Returns -1 if the encoder has not been initialised
address:	The address of the EnDat encoder register to be read

EXAMPLES:

EXAMPLE 1

Initialise and check an EnDat encoder

```
    ENCODER_BITS=25+256*12
    ATYPE=47
    IF ENCODER_READ($A700)=-1 then
      PRINT “Failed to initialise EnDat Encoder
    ENDIF
    ENCODER_CONTROL=0
```

EXAMPLE 2

Read the number of encoder bits from an EnDat encoder. This can be done before **ENCODER_BITS** is set to find the correct value to use. This command will work with any EnDat 2.1 encoder.

```
>>BASE(1)
>>PRINT ENCODER_READ($A10d)AND $3F
25
>>
```

SEE ALSO:

ENCODER_CONTROL, ENCODER_WRITE

ENCODER_STATUS

TYPE:

Axis Parameter

DESCRIPTION:

This axis parameter returns both the status field SF and the **ALMC** encoder error field from a Tamagawa absolute encoder.

VALUE:

Bits 0..7	SF field
Bits 8..15	**ALMC** field

Value is 0 if the encoder has not been initialised

EXAMPLE:

Print the SF field and **ALMC** field in hex

```
PRINT “SF field = 0x”; HEX (ENCODER_STATUS AND $FF)
PRINT “ALMC field = 0x”; HEX ((ENCODER_STATUS AND $FF00)/$FF)
```

ENCODER_TURNS

TYPE:

Axis Parameter

DESCRIPTION:

Returns the number of multi-turn counts from EnDat or Tamagawa absolute encoders.

The multi-turn data is not automatically applied to the axis **MPOS** after initialisation of a Tamagawa absolute encoder. The application programmer must apply this from BASIC using **OFFPOS** or **DEFPOS** as required.

VALUE:
The number of multi-turn counts from the encoder.

EXAMPLE:
Initialise a Tamagawa encoder and apply the number of turns to **MPOS**. The encoder returns 17bits for the position and 16bits for the number of turns.

```
ATYPE=46
OFFPOS= ENCODER_TURNS*2^17
WAIT UNTIL OFFPOS = 0
```

ENCODER_WRITE

TYPE:
Axis Function

SYNTAX:
```
Value = ENCODER_WRITE (address, data)
```

DESCRIPTION:
Write an internal register to an Absolute Encoder on an EnDat absolute encoder.

PARAMETERS:

value:	Returns **TRUE** if the write was successful and **FALSE** if it fails
address:	The address of the EnDat encoder register to be written to
data:	Value to be written to the specified register.

EXAMPLE:
Write a value to the EnDat encoder and check it has been written, then set the encoder back to position mode

```
IF NOT ENCODER_WRITE (endat_address, setvalue) THEN
  PRINT “Fail to write to encoder”
ENDIF
ENCODER_CONTROL=0
```

SEE ALSO:

ENCODER_CONTROL, ENCODER_READ

END_DIR_LAST

TYPE:

Axis Parameter

DESCRIPTION:

Returns the direction of the end of the last loaded interpolated motion command. You can use the parameter to set an initial direction before loading a SP motion command. **END_DIR_LAST** will be the same as **START_DIR_LAST** except in the case of circular moves.

Write to **END_DIR_LAST** when initialising a system or after a sequence of moves which are not **SP** commands.

This parameter is only available when using **SP** motion commands such as **MOVESP**, **MOVEABSSP** etc.

VALUE:

End direction, in radians between -PI and PI. Value is always positive.

EXAMPLES:

EXAMPLE1:

Return the end direction of a move.

```
>>MOVESP(10000,-10000)
>>PRINT END_DIR_LAST
2.3562
>>
```

EXAMPLE 2:

Write to the end direction to set the direction of the **MOVE** before calculating the change.

```
MOVE(10000,-10000)
END_DIR_LAST = 2.3562
MOVESP(10000,1324)
VR(10)=CHANGE_DIR_LAST
```

SEE ALSO:

CHANGE_DIR_LAST, START_DIR_LAST

ENDMOVE

TYPE:
Axis Parameter

DESCRIPTION:
This parameter holds the absolute position of the end of the current move in user units. It is normally only read back although may be written to if required provided that **SERVO**=ON and no move is in progress.

Writing to **DPOS** will make a step changes. This can easily lead to “Following error exceeds limit” errors unless the steps are small or the **FE_LIMIT** is high.

As it is an absolute value **ENDMOVE** is adjusted by **OFFPOS**/**DEFPOS**. The individual moves in the buffer are incremental and are not adjusted by **OFFPOS**.

VALUE:
The absolute position of the end of the current move in user **UNITS**.

EXAMPLE:
Check the value of **ENDMOVE** to confirm you calculated move is correct.

```
MOVE(distance*pitch)
IF ENDMOVE>200 THEN
  CANCEL
  PRINT#5, "Calculated distance to large"
ENDIF
```

ENDMOVE_BUFFER

TYPE:
Axis Parameter (Read only)

DESCRIPTION:
This holds the absolute position of end of the buffered sequence of moves.

As it is an absolute value **ENDMOVE_BUFFER** is adjusted by **OFFPOS**/**DEFPOS**. The individual moves in the buffer are incremental are not adjusted by **OFFPOS**.

VALUE:
Returns the length of all remaining moves for an axis.

EXAMPLE:
Add some moves to the buffer, then check the value of **ENDMOVE_BUFFER**

```
>>MOVE(100)
>>MOVE(150)
>>MOVE(25)
>>PRINT ENDMOVE_BUFFER
275.000
>>
```

ENDMOVE_SPEED

TYPE:
Axis Parameter

DESCRIPTION:
This parameter sets the end speed for a motion command that support the advanced speed control (commands ending in SP). The **VP_SPEED** will decelerate until **ENDMOVE_SPEED** is reached at the end of the profile.

The lowest value of **ENDMOVE_SPEED**, **FORCE_SPEED** or **STARTMOVE_SPEED** will take priority.

ENDMOVE_SPEED is loaded into the buffer at the same time as the move so you can set different speeds for subsequent moves. If there is no further motion commands in the buffer the current move will decelerate to a stop.

VALUE:
The speed at which the SP motion command will end, in user **UNITS**. (default 0)

EXAMPLES:

EXAMPLE 1:
In this example the controller will start ramping down the speed (at the specified rate of **DECEL**) so at the end of the **MOVESP**(20) the **VP_SPEED**=10. The next move continues with a **FORCE_SPEED** of 10. The final **ENDMOVE_SPEED** is overwritten to zero as there are no more buffered moves.

```
FORCE_SPEED=15
ENDMOVE_SPEED=10
MOVESP(20)
FORCE_SPEED=10
ENDMOVE_SPEED=5
```

```
    MOVESP(5)
```

EXAMPLE 2:
A machine can merge interpolated moves however it must slow down to 50% of the speed for the transition.

```
    FORCE_SPEED=1000
    ENDMOVE_SPEED=500 '50% of FORCE_SPEED
    MOVE(100,10)
    MOVE(70,-10)
    MOVE(120,15)
```

EPROM

TYPE:
Reserved Keyword

EPROM_STATUS

TYPE:
Reserved Keyword

= Equals

TYPE:
Mathematical operator
(Comparison or assignment operator).

COMPARISON OPERATOR:

SYNTAX:
`<expression1> = <expression2>`

DESCRIPTION:
Returns **`TRUE`** if expression1 is equal to expression2, otherwise returns **`FALSE`**.

PARAMETERS:

Expression1:	Any valid TrioBASIC expression
Expression2:	Any valid TrioBASIC expression

EXAMPLE:
```
    IF IN(7)=ON THEN GOTO label
```
If input 7 is ON then program execution will continue at line starting “label:”

ASSIGNMENT OPERATOR:

SYNTAX:
```
Value = expression
```

DESCRIPTION:
Assigns a value from the result of the expression.

PARAMETERS:

value:	the variable in which to store the value
expression:	any valid TrioBASIC expression

EXAMPLE:
Set the sum of 10 and 9 into local variable ‘result’
```
    result = 10 + 9
```

ERROR_AXIS

TYPE:
System Parameter (Read Only)

DESCRIPTION:
Returns the number of the axis that caused the **MOTION_ERROR**.

ERROR_AXIS should only be read when **MOTION_ERROR**<>0

VALUE:
Number of the axis that caused the **MOTION_ERROR**

This default value is 0 and is reset to 0 after **DATUM**(0)

EXAMPLE:
If there is a motion error print error information.

```
    IF MOTION_ERROR THEN
      PRINT#5, "Axis to cause error = "; ERROR_AXIS
      PRINT#5, "AXISSTATUS of ERROR_AXIS = "; AXISSTATUS AXIS( ERROR_AXIS)
    ENDIF
```

SEE ALSO:
AXISSTATUS, MOTION_ERROR, FE_LATCH

ERROR_LINE

TYPE:
Process Parameter (Read Only)

DESCRIPTION:
Stores the number of the line which caused the last Trio **BASIC** error. This value is only valid when the **BASICERROR** is **TRUE**.

This parameter is held independently for each process.

VALUE:
The line number on the specified process that caused the error

EXAMPLE:
Display the **ERROR_LINE** as part of a sub routine called by 'ON **BASICERROR GOTO**'

```
    error_routine:
      VR(100) = RUN_ERROR
      PRINT "The error ";RUN_ERROR[0];
      PRINT " occurred in line ";ERROR_LINE[0]
    STOP
```

SEE ALSO:
BASICERROR, RUN_ERROR

ERRORMASK

TYPE:
Axis Parameter

DESCRIPTION:

The value held in this parameter is bitwise ANDed with the **AXISSTATUS** parameter by every axis on every servo cycle to determine if a runtime error should switch off the enable (**WDOG**) relay. If the result of the AND operation is not zero the enable relay is switched off.

After a critical error has tripped the enable relay, the *Motion Coordinator* must either be reset, or a **DATUM**(0) command must be executed to reset the error flags.

VALUE:

The mask to be ANDed with the **AXISSTATUS**

For the MC464, the default value is 268 which will trap critical errors. This is **AXISSTATUS** bits 2, 3 and 8 which are digital drive communication errors and exceeding the following error limit.

EXAMPLE:

Configure the **ERRORMASK** so that the **WDOG** is turned off when there are communication failures (4), remote drive errors (8), the following error exceeds the limit (256) or the limit switches have been hit(16 + 32).

```
    ERRORMASK= 4+8+16+32+256
```

SEE ALSO:

AXISSTATUS, DATUM(0)

ETHERCAT

TYPE:

System Command

SYNTAX:

```
ETHERCAT(function, slot [,parameters…])
```

DESCRIPTION:

The command **ETHERCAT** is used to perform advanced operations on the EtherCAT network. In normal use the EtherCAT network will start automatically without the need for any commands in a startup program. Some **ETHERCAT** command functions may be useful when debugging and setting up an EtherCAT system, so a small sub-set is described here.

The **ETHERCAT** command returns **TRUE**(-1) if successful and **FALSE** (0) if the command execution was in error. Functions which return a value must either put the value in a **VR** or print it to the current output terminal.

PARAMETERS:

function:	Function to be performed	
	$00	Start EtherCAT network
	$01	Stop EtherCAT network
	$21	Set EtherCAT State
	$22	Get EtherCAT State
	$64	Send reset sequence to a drive
	$87	Display network configuration
slot:	Set to the P876 EtherCAT module slot number	

FUNCTION = $00: START ETHERCAT NETWORK

SYNTAX:

```
ETHERCAT(0, slot, [,MAC_retries])
```

DESCRIPTION:

Initialise EtherCAT network, and put it onto operational mode.

PARAMETERS:

MAC_retries:	Sets the number of times the master attempts to restart the Ethernet auto-negotiation. Default = 2.

EXAMPLE:

Check for the EtherCAT state and if not in Operational State, restart the EtherCAT and set an output to indicate that a re-start is in progress.

```
'--Init EtherCAT if needed.
slt=0
ecs_vr=30 'use VR 30 for returned value
chk = ETHERCAT($06,slt,ecs_vr) 'test state

IF chk<>TRUE OR VR(ecs_vr)<>3 THEN
  OP(9,ON)
  WA(15000) 'wait 15sec for drive to power up
  ETHERCAT(0,slt) 'init EtherCAT
ENDIF
```

FUNCTION = $01: STOP ETHERCAT NETWORK

SYNTAX:

```
ETHERNET(1, slot)
```

DESCRIPTION:

Closedown the EtherCAT network.

PARAMETERS:

None.

EXAMPLE:

Stop the EtherCAT protocol from the terminal and then re-start it.

```
    >>ETHERCAT(1, 0)
    >>ETHERCAT(1, 0)
    >>
```

FUNCTION = $21: SET ETHERCAT STATE

SYNTAX:

```
ETHERCAT($21, slot, state, display)
```

DESCRIPTION:

This function controls the EtherCAT State Machine. (ESM) It requests the master change to given EtherCAT ‘state’, and hence changes all slaves to the same state. When a change to a higher state is made, the EtherCAT network will progress to the new state through the in-between states to allow correct starting of the network.

PARAMETERS:

state:	EtherCAT state request	
	-1	Reserved
	0	Initial (EtherCAT ESC value 0x01)
	1	Pre-Operational (0x02)
	2	Safe-Operational (0x04)
	3	Operational (0x08)

display:	Function	
	1	Writes state change information to the standard output stream. (Default)
	0	Do not write out state change information.

EXAMPLE:
Change the EtherCAT to Safe-Operational and suppress the information that would be printed to the terminal.

```
    ETHERCAT($21, 0, 2, 0)
```

FUNCTION = $22: GET ETHERCAT STATE

SYNTAX:
```
ETHERCAT($22, slot, vr_number)
```

DESCRIPTION:
Gets the present state of the EtherCAT running on the defined slot. The value returned shows the EtherCAT state as follows:

- 0 - Initial
- 1 - Pre-oprational
- 2 - Safe-Operational
- 3 - Operational

PARAMETERS:

vr_number:	The **VR** number where the returned value will be put. (-1 forces the value to be printed on the terminal)

EXAMPLE:
In the terminal, request the EtherCAT state value.

```
    >>ETHERCAT($22, 0, -1)
    3
    >>
```

FUNCTION = $64: SEND RESET SEQUENCE TO A DRIVE

SYNTAX:
```
ETHERCAT($64, axis_number[, mode[, timeout]])
```

DESCRIPTION:

Reset a slave error. This function runs the error reset sequence on the drive control word. **DRIVE_CONTROLWORD** bit 8 is toggled high then low. This will instruct the drive to reset any errors in the drive where the cause of the error has been removed.

The response to a reset sequence will depend on the drive and how closely it follows the CoE DS402 specification.

PARAMETERS:

axis_number:	The axis number of the drive to be reset.	
mode:	0	The 'Fault Reset' (bit 7) of DS402 control word is set high and then set low again after a hard coded timeout. (default)
	1	Bit 7 is set high until the 'Fault Flag' (bit 3) of the status word goes low, or a timeout occurs.
timeout:	Optional timeout in msec used during mode 1 operation. Default is 100 msec. Range is 1 to 10000 msec.	

EXAMPLE:

EXAMPLE 1

Send control word reset sequence to drive at axis 8.

```
    ETHERCAT($64, 8)
```

EXAMPLE 2

Send control word reset sequence to drive at axis 2. Use Mode 1 to force the reset bit to remain high until the status it 3 goes low or force the reset bit low again after 60 msec, even if the status bit is still high.

```
    ETHERCAT($64, 2, 1, 60)
```

FUNCTION = $87: DISPLAY NETWORK CONFIGURATION

SYNTAX:

```
ETHERCAT($87, slot)
```

DESCRIPTION:

Displays the network configuration to the command line terminal in *Motion* Perfect.

PARAMETERS:

slot:	The slot number where the EtherCAT module is located

EXAMPLE:

In the terminal, request the EtherCAT network configuration.

```
>>ethercat($87,0)
EtherCAT Configuration (0):
    EK1100       :  0 : 0 : 2000
    EL2008       :  1 : 0 : 1000 (0:0/16:8)
    EL2008       :  2 : 0 : 1001 (0:0/24:8)
    EL2008       :  3 : 0 : 1002 (0:0/32:8)
    EL2008       :  4 : 0 : 1003 (0:0/40:8)
    EL2008       :  5 : 0 : 1004 (0:0/48:8)
    EK1110       :  6 : 0 : 2001
    RS2          :  7 : 0 : 1 (0)
    SGDV         :  8 : 0 : 2 (1)
>>
```

ETHERNET

TYPE:

System Command

SYNTAX:

`ETHERNET(rw, slot, function [,parameters…])`

DESCRIPTION:

The command **ETHERNET** is used to configure the operation of the Ethernet port.

Many of the **ETHERNET** functions are command line only; these are stored in flash EPROM and are then used on power up.

PARAMETERS:

rw:	Specifies the required action.	
	0	Read
	1	Write
slot:	Set to -1 for the built in Ethernet port	

function:	Function to be performed	
	0	IP Address
	1	Reserved function
	2	Subnet Mask
	3	MAC address
	4	Default Port Number
	5	Token Port Number
	6	PRP firmware version (read only)
	7	Modbus TCP mode
	8	Default Gateway
	9	Data configuration
	10	Modbus TCP port number
	11	ARP cache
	12	Reserved function
	13	Reserved function
	14	Configure endpoints for Modbus TCP or Ethernet IP

FUNCTION = 0: IP ADDRESS

SYNTAX:

```
ETHERNET(rw, slot, 0 [,byte1, byte2, byte3, byte4])
```

DESCRIPTION:

Prints or writes the Ethernet IP address. This is command line only.

You must power cycle the controller or perform **EX**(1) to apply the new **IP** address.

PARAMETERS:

byte1:	The first byte of the IP address
byte2:	The second byte of the IP address
byte3:	The third byte of the IP address

byte4:	The fourth byte of the IP address

The default address is 192.168.0.250

EXAMPLE:
Read the current IP address and then set a new IP address into the controller and perform an EX(1) to activate the address

Performing an **EX**(1) as in this example will close the communications and you will only be able to communicate again using the new **IP** address.

```
>>ETHERNET(0, -1, 0)
192.168.0.250
>>ETHERNET(1, -1, 0, 192, 168, 0, 201)
>>EX(1)
>>
```

FUNCTION = 2: SUBNET MASK

SYNTAX:
ETHERNET(rw, slot, 2 [,byte1, byte2, byte3, byte4])

DESCRIPTION:
Prints or writes the Subnet Mask. This is command line only.

You must power cycle the controller or perform **EX**(1) to apply the new **IP** address.

PARAMETERS:

byte1:	The first byte of the Subnet Mask
byte2:	The second byte of the Subnet Mask
byte3:	The third byte of the Subnet Mask
byte4:	The fourth byte of the Subnet Mask

The default Subnet Mask is 255.255.255.0

EXAMPLE:
Read the subnet mask and write a new value

```
    >>ETHERNET(0, -1, 0)
    255.255.255.0
    >>ETHERNET(1, -1, 2, 255, 255, 128, 0)
    >>
```

FUNCTION = 3: MAC ADDRESS

SYNTAX:

`ETHERNET(0, slot, 3)`

DESCRIPTION:

Prints the MAC address. This is command line only.

This function is read only.

PARAMETERS:

The MAC address is unique to your controller.

EXAMPLE:

Read the MAC address of a controller

```
    >>ETHERNET(0, -1, 3)
    00:06:70:00:00:FA
    >>
```

FUNCTION = 4: DEFAULT PORT

SYNTAX:

`ETHERNET(rw, slot, 4 [, port])`

DESCRIPTION:

Prints or writes the default port number. This is command line only.

The default value is used by *Motion* Perfect and PCMotion and should not be changed unless absolutely necessary.

PARAMETERS:

port:	The port used for the main command line in the controller. (default 23)

FUNCTION = 5: TOKEN PORT

SYNTAX:

```
ETHERNET(rw, slot, 5 [, port])
```

DESCRIPTION:

Prints or writes the default port number for token channel which is used by the PCMotion ActiveX control. This is command line only.

The default value is used by the PCMotion ActiveX control and should not be changed unless absolutely necessary.

PARAMETERS:

port:	The port used for the token channel in the controller. (default 3240)

FUNCTION = 6: PRP FIRMWARE VERSION (READ ONLY)

SYNTAX:

```
Ethernet(0,slot,6)
```

DESCRIPTION:

Reads the communications processor s firmware version. This is command line only.

This function is read only

PARAMETERS:

Returns the flash application version and the bootloader version.

EXAMPLE:

Read the communications processor firmware with application version 61 and boot loader version 22.

```
    >>ETHERNET(0, -1, 6)
    61;22
    >>
```

FUNCTION = 7: MODBUS TCP MODE

SYNTAX:

```
Ethernet(rw, slot, 7 [,mode])
```

DESCRIPTION:

Sets the Modbus TCP data type. This value is stored in RAM and so must be initialised every time the controller powers up. This can be done in a TrioBASIC program for example **STARTUP**

This must be configured before the Modbus master opens the port.

PARAMETERS:

mode:	0	16bit integer (default value)
	1	32bit single precision floating point without address halving
	2	32bit long word integers without address halving

If you want to use address halving please see **ETHERNET** Function 14

EXAMPLE:

Initialise the Modbus TCP port for floating point data.

```
    ETHERNET(1,-1,7,1)
```

FUNCTION = 8: DEFAULT GATEWAY

SYNTAX:

```
ETHERNET(rw, slot, 8 [,byte1, byte2, byte3, byte4])
```

DESCRIPTION:

Prints or writes the Default Gateway. This is command line only.

You must power cycle the controller or perform **EX**(1) to apply the new Default Gateway.

PARAMETERS:

byte1:	The first byte of the Default Gateway
byte2:	The second byte of the Default Gateway

byte3:	The third byte of the Default Gateway
byte4:	The fourth byte of the Default Gateway

EXAMPLE:

Print then change the value of the default gateway.

```
    >>ETHERNET(0, -1, 8)
    192.168.0.225
    >> ETHERNET(0,-1, 8, 192, 168, 0, 150)
    >>
```

FUNCTION = 9: DATA CONFIGURATION

SYNTAX:

`Ethernet(rw, slot, 9 [,mode])`

DESCRIPTION:

Sets the Modbus TCP data source. This value is stored in RAM and so must be initialised every time the controller powers up. This can be done in a TrioBASIC program for example **STARTUP**

This must be configured before the Modbus master opens the port.

PARAMETERS:

mode:	0	VR (default value)
	1	Table

EXAMPLE:

Initialise the Modbus TCP port for table data.

```
    ETHERNET(2, -1, 9, 1)
```

FUNCTION = 10: MODBUS TCP PORT NUMBER

SYNTAX:

`ETHERNET(rw, slot, 10 [, port])`

DESCRIPTION:

Prints or writes the default port number for token channel which is used by Modbus TCP. This is command line only.

The default value is used by Modbus and should not be changed unless absolutely necessary.

PARAMETERS:

port:	The port used for the token channel in the controller. (default 502)

FUNCTION = 11: ARP CACHE

SYNTAX:
`Ethernet(0, slot, 11)`

DESCRIPTION:
Reads the ARP cache. This is command line only.

This function is read only

FUNCTION = 14: ENDPOINTS FOR MODBUS TCP OR ETHERNET IP

SYNTAX:
`ETHERNET(1, slot, 14, endpoint_id, parameter_index, parameter_value )`

DESCRIPTION:
This function allows the user to configure Ethernet IP and Modbus at a low level. The default values allow a master to connect without any configuration on the Controller side. These settings are stored in RAM and so must be initialised every time the controller powers up. This can be done in a TrioBASIC program for example **STARTUP**.

PARAMETERS:

endpoint_id:	This allows you to specify which end point you are reading or writing	
	0	Modbus TCP
	1	Ethernet IP Assembly Object, Instance 100 (input)
	2	Ethernet IP Assembly Object, Instance 101 (output)

parameter_index:	This parameter selects which of the endpoint variables you are reading or writing	
	0	Address
	1	Data location
	2	Data format
	3	Length
	4	Class
	5	Instance
	6	Operation Mode
parameter_value:	Dependent on Parameter index, see table below	

PARAMETER VALUES:

parameter_index	parameter_value	
0	The start position of the data location.	
1	The location of the data on the controller.	
	0	Register (reserved use)
	1	IO input
	2	IO output
	3	VR (default value)
	4	Table
	5	Digital IO Input
	6	Digital IO Output
	7	Analogue IO Input
	8	Analogue IO Input
2	The precision of the data.	
	0	Integer 16 bit (default value)
	1	Integer 32 bit
	2	Floating point 32 bit
	3	Floating point 64 bit

3	The number of the data locations returned.	
4	The class. This function is read only.	
	4	Ethernet IP
	68	Modbus
5	The instance of the endpoint. This function is read only.	
	0	Modbus
	100	Ethernet IP input
	101	Ethernet IP output
6	The Operation mode. Read/write.	
	0	Modbus TCP uses normal addressing
	1	Modbus TCP uses “address halving”

EXAMPLES:

EXAMPLE 1:

Configure Modbus using Function 14 to use Table and floating point 64bit

```
ETHERNET(1, -1, 14, 0, 1, 4)
ETHERNET(1, -1, 14, 0, 2, 3)
```

EXAMPLE 2:

Configure Ethernet IP for 50 **TABLE** inputs starting at 200 and 50 table outputs starting at 300 all at 32bit float

```
 'Inputs
ETHERNET(1, -1, 14, 1,0,200)
ETHERNET(1, -1, 14, 1, 1, 4)
ETHERNET(1, -1, 14, 1, 2, 2)
ETHERNET(1, -1, 14, 1, 3, 50)
 'Outputs
ETHERNET(1, -1, 14, 2,0,300)
ETHERNET(1, -1, 14, 2, 1, 4)
ETHERNET(1, -1, 14, 2, 2, 2)
ETHERNET(1, -1, 14, 2, 3, 50)
```

EXAMPLE 3:

Configure Modbus TCP floating point **TABLE** access, using address halving to match the addressing scheme used in the master.

```
ETHERNET(1, -1, 14, 0,2,2)
```

```
    ETHERNET(1, -1, 14, 0, 1, 4)
    ETHERNET(1, -1, 14, 0, 6, 1)
```

EX

TYPE:
System Command

SYNTAX:
`EX(processor)`

DESCRIPTION:
Software reset. Resets the controller as if it were being powered up.

When performing an **`EX`** on the command line you will see the controller start up information that provides details of your controller configuration.

On **`EX`** the following actions occur:

- The global numbered (**`VR`**) variables remain in memory.
- The base axis array is reset to 0,1,2... on all processes
- Axis errors are cleared
- Watchdog is set **`OFF`**
- Programs may be run depending on **`POWER_UP`** and **`RUNTYPE`** settings
- **`ALL`** axis parameters are reset.

`EX` may be included in a program. This can be useful following a run time error. Care must be taken to ensure it is safe to restart the program.

When running *Motion* Perfect executing an **`EX`** command is not allowed. The same effect as an **`EX`** can be obtained by using "Reset the controller..." under the "Controller" menu in *Motion* Perfect. To simply re-start the programs, use the **`AUTORUN`** command.

PARAMETERS:

0 or None:	Software resets the controller and maintains communications.
1:	Software resets the controller and communications.

When you use **`EX`**(1) you will have to remake the Ethernet connection

EXECUTE

TYPE:
System Command

DESCRIPTION:
Used to implement the remote command execution via the Trio PCMotion ActiveX. For more details see the section on using the PCMotion

EXP

TYPE:
Mathematical Function

SYNTAX:
`EXP(expression)`

DESCRIPTION:
Returns the exponential value of the expression.

PARAMETERS:

expression:	Any valid TrioBASIC expression

EXAMPLE:
Print the expontential value of 1

```
    >>PRINT EXP(1)
    2.7183
>>
```

FALSE

TYPE:
Constant

DESCRIPTION:
The constant **FALSE** takes the numerical value of 0.

EXAMPLE:
```
test:
Use FALSE as part of a logical check
  res = IN(0) OR IN(2)
  IF res = FALSE THEN
    PRINT "Inputs are off"
  ENDIF
```

FAST_JOG

TYPE:
Axis Parameter

DESCRIPTION:
This parameter holds the input number to be used as the fast jog input. If the **FAST_JOG** is active then the jog inputs use the axis **SPEED** for the jog functions, otherwise the **JOGSPEED** will be used.

The input used for **FAST_JOG** is active low.

VALUE:

-1	disable the input as **FAST_JOG** (default)
0-63	Input to use as datum input

Any type of input can be used, built in, Trio CAN I/O, CANopen or virtual.

EXAMPLE:
Configure input 12 and 13 as jog inputs
```
FWD_JOG = 12
FAST_JOG = 13
JOGSPEED = 200
```

SEE ALSO:
FWD_JOG, JOGSPEED, REV_JOG

FASTDEC

TYPE:
Axis Parameter

DESCRIPTION:
The **FASTDEC** axis parameter may be used to set or read back the fast deceleration rate of each axis fitted. Fast deceleration is used when a **CANCEL** is issued, for example; from the user, a program, or from a software or hardware limit. If the motion finishes normally or **FASTDEC** = 0 then the **DECEL** value is used.

VALUE:
The deceleration rate in **UNITS**/sec/sec. Must be a positive value.

EXAMPLE:
```
    DECEL=100               'set normal deceleration rate
    FASTDEC=1000            'set fast deceleration rate
    MOVEABS(10000)          'start a move
    WAIT UNTIL MPOS= 5000   'wait until the move is half finished
    CANCEL                  'stop move at fast deceleration rate
```

SEE ALSO:
DECEL

FE

TYPE:
Axis Parameter (Read Only)

DESCRIPTION:
This parameter returns the position error, which is equal to the demand position (**DPOS**) - measured position (**MPOS**).

VALUE:
The following error returned in user **UNITS**.

EXAMPLE:

Wait for the position error to be below a value for 5 servo periods then pulse an output.

```
MOVEABS(200)
WAIT IDLE
FOR x=0 to 4
    WAIT UNTIL FE<5
NEXT x
OP(5,ON)
WA(2)
OP(5,OFF)
```

SEE ALSO:

FE_LATCH, FE_LIMIT, FE_RANGE

FE_LATCH

TYPE:

Axis Parameter (Read Only)

DESCRIPTION:

Contains the FE value which caused the axis to put the controller into **MOTION_ERROR**. This value is only set when the FE exceeds the **FE_LIMIT** and the **SERVO** = OFF.

VALUE:

Returns the FE value that caused a **MOTION_ERROR**

FE_LATCH is reset to 0 when the axis **SERVO** = **ON**.

EXAMPLE:

Read the **LE_LATCH** when there is a **MOTION_ERROR**

```
IF MOTION_ERROR THEN
  VR(10) = FE_LATCH AXIS (ERROR_AXIS)
ENDIF
```

SEE ALSO:

FE, FE_LIMIT

FE_LIMIT

TYPE:
Axis Parameter

ALTERNATE FORMAT:
FELIMIT

DESCRIPTION:
This is the maximum allowable following error. When exceeded the controller will generate an **AXISSTATUS** error, by default this will also generate a **MOTION_ERROR**. The **MOTION_ERROR** will disable the **WDOG** relay thus stopping further motor operation.

This limit may be used to guard against fault conditions such as mechanical lock-up, loss of encoder feedback, etc.

VALUE:
The maximum allowable following error in user units. The default value is 2000 encoder edges.

EXAMPLE:
Initialise the axis as part of a **STARTUP** routine

```
    FOR x = 0 to 4
      BASE(x)
      UNITS = 100
      FE_LIMIT = 10
      SPEED = 100
      ACCEL=1000
      DECEL=ACCEL
    NEXT x
```

SEE ALSO:
FE, FE_LATCH

FE_LIMIT_MODE

TYPE:
Axis Parameter

DESCRIPTION:
This parameter determines if an **AXISSTATUS** error is produced immediately when the FE exceeds the

FE_LIMIT or if it exceeds for 2 consecutive servo periods. This means that if **FE_LIMIT** is exceeded for one servo period only, it will be ignored.

This will increase the time to disable your drives in an error. You should only change from the default values under advice from Trio or your distributor.

VALUE:

0	**AXISSTATUS** error generated immediately (default)
1	**AXISSTATUS** error generated when **FE_LIMIT** is exceeded for 2 consecutive servo periods.

SEE ALSO:

FE, FE_LIMIT

FE_RANGE

TYPE:

Axis Parameter

DESCRIPTION:

Following error report range. When the FE exceeds this value the axis has bit 1 in the **AXISSTATUS** axis parameter set.

VALUE:

The value in user **UNITS** above which bit 1 is set in **AXISSTATUS**

EXAMPLE:

Using **FE_RANGE** to slow a machine down when the FE is too large.

```
'initialise the axis
FE_RANGE = 10
FE_LIMIT = 15
SPEED=100
…
'loop to check if FE_RANGE has been exceeded
WHILE NOT IDLE
VR(10) = AXISSTATUS
IF READBIT(1, 10) THEN
  'slow down by 1%
  SPEED = SPEED * 0.99
ENDIF
```

```
    WEND
    SPEED = 100
```

SEE ALSO:

FE, FE_LIMIT

FEATURE_ENABLE

TYPE:

System Command

SYNTAX:

`FEATURE_ENABLE([feature _number [, "password"]])`

DESCRIPTION:

*Motion Coordinator*s have the ability to unlock additional features by entering a "Feature Enable Code". This function is used to enable protected features, such as additional remote axes on digital dive networks or other programming languages. This can only be run on the command line.

It is recommended to use *Motion* Perfect to enter and store the feature enable codes.

The password parameter is optional, if it is omitted then the command will prompt you to enter it.

You can purchase additional feature codes from the Trio Website or through your distributor, you will need the **SERIAL_NUMBER** of the controller.

If you enter the wrong password 3 times the controller will enter an attack state where it stops communicating. You can resume normal operation by power cycling the controller.

PARAMETERS:

feature_number:	None	Prints the security code and currently enabled features.
	0	1 remote axis
	1	2 remote axes
	2	4 remote axes
	3	8 remote axes
	4	16 remote axes
	5	32 remote axes
	6-11	Reserved use
	12	1 remote axis
	13	2 remote axes
	14	4 remote axes
	15	8 remote axes
	16	16 remote axes
	17	32 remote axes
	18-20	Reserved use
	21	IEC runtime
	22-31	Axis upgrade
	24-31	Reserved use
password:	The password for the required feature code	

When entering a feature a password is requested

When entering a password always enter the characters in upper case. Take care to check that 0 (zero) is not confused with O and 1 (one) is not confused with I.

EXAMPLES:

EXAMPLE 1:

Check the enabled features on a controller

```
>>FEATURE_ENABLE
Security code=17980000000028
Enabled features: 0 1
```

Features 0 and 1 are enabled so an additional 3 axes on top of the built in axes included with the module.

EXAMPLE 2:

Enable an additional 4 axes (feature 2). For this controller and this feature, the password is 5P0APT.

```
>>FEATURE_ENABLE(2)
Feature 2 Password=5P0APT
>>
>>FEATURE_ENABLE
Security code=17980000000028
Enabled features: 0 1 2
```

SEE ALSO:

SERIAL_NUMBER

FHOLD_IN

TYPE:

Axis Parameter

ALTERNATE FORMAT:

FH_IN

DESCRIPTION:

This parameter holds the input number to be used as a feedhold input.

When the feedhold input is active motion on the specified axis has its speed overridden to the feedhold speed (**FHSPEED**) without canceling the move in progress. The change in speed uses **ACCEL** and **DECEL**. When the input is reset any move in progress when the input was set will go back to the programmed speed.

Set **FHSPEED** to zero to pause the motion on that axis

Moves which are not speed controlled e.g. **CONNECT**, **CAMBOX**, **MOVELINK** are not affected.

The input used for **FHOLD_IN** is active low.

VALUE:

-1	disable the input as feedhold (default)
0-63	Input to use as feedhold

Any type of input can be used, built in, Trio CAN I/O, CANopen or virtual.

EXAMPLE:
Configure inputs 21 as feedhold inputs for axis 2. The default **FHSPEED** = 0 so the motion can be paused using the feedhold input.

SEE ALSO:
FHSPEED

FHSPEED

TYPE:
Axis Parameter

DESCRIPTION:
When the feedhold input is active motion is ramped down to **FHSPEED**.

VALUE:
The speed in user units to use when the **FHOLD_IN** is active (default 0)

EXAMPLE:
Set **FHSPEED** to a value so that a slower speed is selected wen the **FHOLD_IN** is active

```
BASE(3)
SPEED=1000
FHSPEED=SPEED*0.1
```

SEE ALSO:
FHOLD_IN

FILE

TYPE:
System Command

SYNTAX:
```
value = FILE "function" [parameters]
```

DESCRIPTION:
This command enables the user to manage the data on the SD Card.

When the command prints to the selected channel, this channel can be selected using **OUTDEVICE**

PARAMETERS:

function:	CD	Change directory
	DEL	Delete file
	DETECT	Check for SD Card
	DIR	Print the current directory contents
	FIND_CLOSE	Ends the find session
	FIND_FIRST	Finds the first entry in the directory structure of the specified file type
	FIND_NEXT	Finds the next entry in the directory structure of the specified file type
	FIND_PREV	Finds the previous entry in the directory structure of the specified file type
	LOAD_PROGRAM	Loads the specified program to the controllers memory
	LOAD_PROJECT	Loads the specified project into the controllers memory
	LOAD_SYSTEM	Loads the specified firmware into the controller
	RD	Remove (delete) a directory
	MD	Make (create) a directory
	PWD	Prints the path of the directory
	SAVE_PROGRAM	Saves the specified program to the SD Card
	SAVE_PROJECT	Saves all programs from the controller to the SD Card.
	TYPE	Prints the selected file
parameters:	dependent on the function	
value:	returns **TRUE** if the function was successful otherwise returns **FALSE**	

FUNCTION = CD:

SYNTAX:

```
value = FILE “CD” “directory”
```

DESCRIPTION:

Change to the given directory. There is one active directory on the controller all SD Card commands are relative to this directory.

PARAMETERS:

directory:	string	The name of the child directory to move to
	\\	Move to the root directory
	..	Move up one level to the parent directory

EXAMPLES:

EXAMPLE 1

Use the command line to change to a new directory

```
    >>file “CD” “new_directory”
    OK \NEW_DIRECTORY
    >>
```

EXAMPLE 2

Use the command line to change to a new directory 3 levels below

```
    >>file “CD” “ project1\\project2\\project3”
    OK \PROJECT1\PROJECT2\PROJECT3
    >>
```

EXAMPLE 3

Use the command line to move to the root directory

```
    >>file “CD” “\\”
    OK \
    >>
```

FUNCTION = DEL:

SYNTAX:

value = **FILE** “DEL” “file”

DESCRIPTION:
Delete the given file inside the current directory.

PARAMETERS:

file:	The name of the file to be deleted, you must include the file extension

EXAMPLE:
Delete a `BASIC` program from the SD Card using the command line.

```
    >>FILE "DEL" "STARTUP.bas"
    OK
    >>
```

FUNCTION = DETECT:

SYNTAX:
`value = FILE "DETECT"`

DESCRIPTION:
Checks if a SD Card is present in the slot

RETURN VALUE:
`TRUE` if an SD Card is detected correctly, otherwise `FALSE`.

EXAMPLE:
Check if an SD card is present before saving the table data.

```
    IF FILE "DETECT" THEN
      STICK_WRITE(1501, 1000, 2000, 0)
    ENDIF
```

FUNCTION = DIR:

SYNTAX:
`value = FILE "DIR"`

DESCRIPTION:
Print the contents of the current directory to the current output channel.

EXAMPLE:

Print the contents of the SD card on the command line.

```
>>FILE "DIR"
 Volume is NO NAME
 Volume Serial Number is 00C8-B79F
 Directory of \
07/Aug/2009 15:50    1169978 MC60CC~1.OUT MC464_20055__BOOT_013.out
20/Nov/2009 15:25 <DIR>      MC464_~1     MC464_Panasonic_Home
16/Feb/2009 13:16       1619 TRIOINIT.BAS TRIOINIT.BAS
20/Nov/2009 15:21 <DIR>      SHOW1        Show1
07/Jan/2000 04:54 <DIR>      NEW_DI~1     NEW_DIRECTORY
>>
```

FUNCTION = FIND_CLOSE:

SYNTAX:

`value = FILE "FIND_CLOS"`

DESCRIPTION:

Closes the internal **FIND** structure. Use when you have finished with **FIND_NEXT** and **FIND_PREVIOUS**.

FUNCTION = FIND_FIRST:

SYNTAX:

`value = FILE "FIND_FIRST", type, vr_index`

DESCRIPTION:

Initialises the internal **FIND** structures and locates the first directory entry of the given type. The found directory entries name is stored in a **VRSTRING**

PARAMETERS:

value:	**TRUE** if a directory entry is found otherwise **FALSE**	
type:	1	**FILE**
	2	**DIRECTORY**
vr_index:	The start position in **VR** memory where the **VRSTRING** is stored	

If there is an error initialising the internal **FIND** structures then the function returns **FALSE**.

FUNCTION = FIND_NEXT:

SYNTAX:

`value = FILE "FIND_NEXT", vr_index`

DESCRIPTION:

Finds the next directory entry of the type given in the corresponding **`FIND_FIRST`** command.

PARAMETERS:

value:	**TRUE** if a directory entry is found otherwise **FALSE**
vr_index:	The start position in **VR** memory where the **VRSTRING** is stored

If there is an error initialising the internal **`FIND`** structures then the function returns **`FALSE`**.

FUNCTION = FIND_PREV:

SYNTAX:

`value = FILE  "FIND_PREV", vr_index`

DESCRIPTION:

Finds the previous directory entry of the type given in the corresponding **`FIND_FIRST`** command.

PARAMETERS:

value:	**TRUE** if a directory entry is found otherwise **FALSE**
vr_index:	The start position in **VR** memory where the **VRSTRING** is stored

If there is an error initialising the internal **`FIND`** structures then the function returns *FALSE*.

FUNCTION = LOAD_PROGRAM:

SYNTAX:

`value = FILE  "LOAD_PROGRAM" "file"`

DESCRIPTION:
Load the given program into the *Motion Coordinator*. Only .BAS files are handled at present.

PARAMETERS:

file:	The name of the file that you wish to load.

FUNCTION = LOAD_PROJECT:

SYNTAX:

```
value = FILE "LOAD_PROJECT" "name"
```

DESCRIPTION:
Read the given *Motion* Perfect project file and load all the programs into the *Motion Coordinator*, once loaded any RUNTYPEs are automatically set.

PARAMETERS:

name:	The name of the project that you wish to load.

FUNCTION = LOAD_SYSTEM:

SYNTAX:

```
value = FILE "LOAD_SYSTEM" "name"
```

DESCRIPTION:
Loads system firmware onto the controller.

PARAMETERS:

name:	The name of the firmware file that you wish to load.

Loading incorrect firmware can prevent your controller from operating

FUNCTION = RD:

SYNTAX:

```
value = FILE "RD" "name"
```

DESCRIPTION:
Delete the given directory inside the current directory.

PARAMETERS:

name:	The name of the directory that you wish to delete.

FUNCTION = MD:

SYNTAX:
`value = FILE "MD" "name"`

DESCRIPTION:
Create the given directory inside the current directory.

PARAMETERS:

name:	The name of the directory that you wish to create.

EXAMPLE:
Using the command line create a new directory.

```
>>FILE "MD" "new_directory"
OK
>>
```

FUNCTION = PWD:

SYNTAX:
`value = FILE "PWD"`

DESCRIPTION:
Prints the path of the current directory to the current output channel.

FUNCTION = SAVE_PROGRAM:

SYNTAX:
`value = FILE "SAVE_PROGRAM" "name" ["extension"]`

DESCRIPTION:

Save the named file from the controllers memory to the SD card. If the extension is omitted then the default file extensions BAS, TXT or **`TEMP`** are used.

PARAMETERS:

name:	The name of the file that you wish to save to the SD Card.
extension:	Optional to define the file extension to be used

FUNCTION = SAVE_PROJECT:

SYNTAX:

`value = FILE "SAVE_PROJECT" "name"`

DESCRIPTION:

Create a *Motion* Perfect project with the given name inside the current directory. This implies creating the directory and the corresponding project and program files within this directory.

PARAMETERS:

name:	The name of the project that you are creating on the SD Card

FUNCTION = TYPE:

SYNTAX:

`value = FILE "TYPE" "name"`

DESCRIPTION:

Read the contents of the file inside the current directory and print it to the current output channel.

PARAMETERS:

name:	The name of the file that you wish to print

SEE ALSO

`OUTDEVICE, STICK_READ, STICK_WRITE, STICK_READVR, STICK_WRITEVR`

FILLET

TYPE:
Mathematical function

SYNTAX:
`FILLET(data_in, data_out, options)`

DESCRIPTION:
The **FILLET** function has 2 calculation functions:

The first function allows the dimensions of an arc that fillets or blends two 3-D vectors together to be easily calculated.

The second function allows the dimensions of two 2D arcs that blends 2 points with directions to be easily calculated.

PARAMETERS:

data_in:	Location of the input data in **TABLE** memory.	
data_out:	Location of the output data in **TABLE** memory.	
options:	0	Used to calculate the arc between 2 straight lines in 3D.
	1	Calculates a pair of arcs between 2 points with directions.

OPTION = 0

DESCRIPTION:
The function calculates the start, end, midpoint and centre of the 3D arc. The arc may easily be converted into motion using the **MSPHERICAL** command.

FILLET only works in system version 2.0220 and higher which outputs 19 data values including the fillet angle and fillet length.

PARAMETERS:
Input data: (7 data values required)

Table data	0	x vector A
	1	y vector A
	2	z vector A
	3	x vector B
	4	y vector B
	5	z vector B
	6	radius

Output data: (19 data values are output)

Table data	0	x A remain
	1	y A remain
	2	z A remain
	3	end x
	4	end y
	5	end z
	6	mid x
	7	mid y
	8	mid z
	9	centre x
	10	centre y
	11	centre z
	12	error
	13	output radius
	14	x B remain
	15	y B remain
	16	z B remain
	17	angle change
	18	fillet length

A remain: the xyz position of the start of arc relative to the start of the incoming vector.

Mid: the xyz position of a mid-point on the fillet arc relative to the start of arc.

Centre: the xyz position of the arc centre relative to the start of arc.

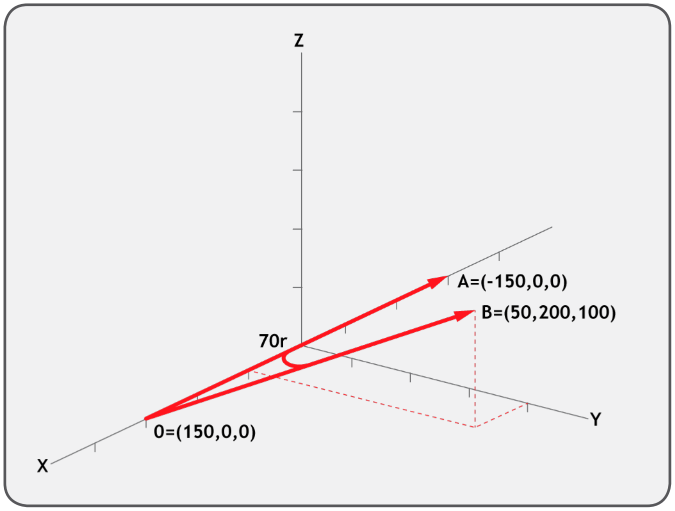
Error: set to 0 if no error, 1 = one or both vectors is zero length, 2 = vectors are co-linear.

Output radius: If the vectors are not long enough to allow the requested radius to be filleted (taking into account the options value) the output radius value will show the maximum possible otherwise will reflect the input radius.

B remain: the xyz position of the end of the outgoing vector relative to the end of the arc.

EXAMPLE:

Calculate the fillet of two 3D vectors and represent them by **MOVE** command for the vectors and **MSPHERICAL** for the fillet.



```
DEFPOS(150,0,0)

TRIGGER TABLE(100,-150,0,0)
TABLE(103,50,200,100,70)

FILLET(100,200,0)

xin=TABLE(200):yin=TABLE(201):zin=TABLE(202)

MOVE(xin,yin,zin)

xend=TABLE(203):yend=TABLE(204):zend=TABLE(205) xmid=TABLE(206):ymid=TA
```

```
BLE(207):zmid=TABLE(208)

MSPHERICAL(xend,yend,zend,xmid,ymid,zmid,0)

xout=TABLE(214):yout=TABLE(215):zout=TABLE(216)


MOVE(xout,yout,zout)

fillet_ang=TABLE(217):fillet_len=TABLE(218)

PRINT fillet_ang,fillet_len
```

OPTION = 1

DESCRIPTION:

The function calculates the start, end and centre of 2 arcs. The arc may be easily converted into motion using **MOVECIRC** or **MSPHERICAL** commands.

PARAMETERS:

Input data: (10 data values required).

Table data	0	X value point A
	1	Y value point A
	2	X direction point A
	3	Y direction point A
	4	X value point B
	5	Y value point B
	6	X direction point B
	7	Y direction point B
	8	Radius control (Set to 0 to allow **FILLET** to calculate the largest possible radius)
	9	Arc direction mode control: 0 – Use shortest route 1 – **LEFT TURN** - **LEFT TURN** arc forced 2 – **RIGHT TURN** - **RIGHT TURN** arc forced 3 – **LEFT TURN** then **RIGHT TURN** arc forced 4 – **RIGHT TURN** then **LEFT TURN** arc forced

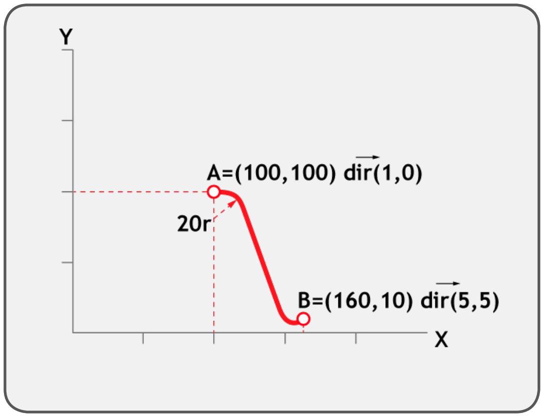
The direction at a point is specified using a pair of +/- incremental values. This need not be normalised to a length of 1 by the user. For example a direction along the X axis can be specified as (1, 0) a direction in the negative X direction would be (-1, 0). A direction along the Y axis would be (0, 1). Considering an angle to be the +/-PI angle from the Y axis. The direction is (sin(angle), cos(angle)).

Output data: (18 data values are output)

Table data	0	Bit 0 – Arc A Direction Bit 1 – Arc B Direction
	1	1 – **LEFT TURN** arc A then **LEFT TURN** arc B 2 – **RIGHT TURN** arc A then **RIGHT TURN** arc B 3 - **LEFT TURN** arc A then **RIGHT TURN** arc B 4 – **RIGHT TURN** arc A then **LEFT TURN** arc B
	2	X end position relative to start arc A
	3	Y end position relative to start arc A
	4	X centre position relative to start arc A
	5	Y centre position relative to start arc A
	6	X increment linking linear move (0 if radius unlimited)
	7	Y increment linking linear move (0 if radius unlimited)
	8	X end position relative to start arc B
	9	Y end position relative to start arc B
	10	X centre position relative to start arc B
	11	Y centre position relative to start arc B
	12	Error, 0 = no error
	13	Arc A Length
	14	Linking Move Length
	15	Arc B Length
	16	Total Length
	17	Radius calculated. If the radius is limited by the “radius control” input this value will be set to the limit radius.

EXAMPLE:

Calculate the dimensions of two arcs that blends two points with directions and represent them by **MCIRCLE** command.


Y
A=(100,100) $\overrightarrow{dir}(1,0)$
20r
B=(160,10) $\overrightarrow{dir}(5,5)$
X

```
max_r=20
dir_o=0

TABLE(3000,100,100,1,0,160,10,5,5,max_r,dir_o)

FILLET(3000,3200,1)

IF TABLE(3212) THEN
    PRINT "Error in data"
    STOP
ENDIF

direc1=TABLE(3200).0
direc2=TABLE(3200).1

end1x = TABLE(3202)
end1y = TABLE(3203)
cen1x = TABLE(3204)
cen1y = TABLE(3205)

px = TABLE(3206)
py = TABLE(3207)

end2x = TABLE(3208)
end2y = TABLE(3209)
cen2x = TABLE(3210)
cen2y = TABLE(3211)

arc1len = TABLE(3213)
midlen = TABLE(3214)
arc2len = TABLE(3215)

TRIGGER
```

```
    IF arc1len>0 THEN MOVECIRC(end1x,end1y,cen1x,cen1y,direc1)
    IF midlen >0 THEN MOVE(px,py)
    IF arc2len>0 THEN MOVECIRC(end2x,end2y,cen2x,cen2y,direc2)

    WAIT IDLE
```

FLAG

TYPE:
Logical and Bitwise Command

SYNTAX:
value = FLAG(flag_no [,state])

DESCRIPTION:
The **FLAG** command is used to set and read a bank of 24 flag bits.

The **FLAG** command is provided to aid compatibility with earlier controllers and is not recommended for new programs.

PARAMETERS:

value:	With one parameter it returns the state of the flag
	With 2 parameters it returns -1
flag_no:	The flag number is a value from 0..31.
state:	The state to set the given flag to. ON or OFF.

EXAMPLE:
Toggle a flag depending on a **VR** value

```
    IF FLAG(21) and VR(100)=123 THEN
      FLAG(21,OFF)
    ELSE IF NOT FLAG(21) and VR(100)<>123 THEN
      FLAG(21,ON)
    ENDIF
```

FLAGS

TYPE:
Logical and Bitwise Command

SYNTAX:
`value = FLAGS([state])`

DESCRIPTION:
Read or Set the 32bit **FLAGS** as a block.

The **FLAGS** command is provided to aid compatibility with earlier controllers and is not recommended for new programs.

PARAMETERS:

value:	no parameters = returns the status of all flag bits
	with parameter = returns -1
state:	The decimal equivalent of the bit pattern to set the flags to

EXAMPLES:

EXAMPLE 1:
Set Flags 1,4 and 7 ON, all others OFF

Bit #	7	6	5	4	3	2	1	0
Value	128	64	32	16	8	4	2	1

FLAGS(146)’ 2 + 16 + 128

EXAMPLE 2:
Test if **FLAG** 3 is set.

```
    IF (FLAGS and 8) <>0 then GOSUB somewhere
```

FLASH_DATA

TYPE:
Startup Parameter (**MC_CONFIG**)

DESCRIPTION:

FLASH_DATA controls whether **VR** or **TABLE** data is automatically backed up to flash memory.

The default setting (0) will use **VR** memory as the source for backup. However, by changing this parameter to 1 within **MC_CONFIG** will cause **TABLE** data as the source for backup. Please note that regardless of which data source is selected , only the first 4096 elements will be available for automatic backup.

VALUE:

0	VR memory selected for automatic backup (default)
1	**TABLE** memory selected for automatic backup

EXAMPLES:

EXAMPLE 1:

FLASH_DATA = 0 ‘Select **VR** memory for backup

EXAMPLE 2:

FLASH_DATA = 1 ‘Select **TABLE** memory for backup

FLASH_DUMP

TYPE:

Reserved Keyword

FLASHTABLE

TYPE:

System Function

SYNTAX:

FLASHTABLE(function,flashpage,tablepage)

DESCRIPTION:

Copies user data in RAM to and from the permanent **FLASH** memory.

If **FLASHTABLE** is being used then you cannot use **FLASHVR**(-1)

PARAMETERS:

function:	Specifies the required action.	
	1	Write a page of **TABLE** data into flash EPROM.
	2	Read a page of flash memory into **TABLE** data.
flashpage:	The index number (0 ... 31) of a 16000 values page of Flash EPROM where the table data is to be stored to or retrieved from.	
tablepage:	The index number (0 ... INT(**TSIZE**/16000)) of the page in table memory where the data is to be copied from or restored to.	

EXAMPLE:

Save the **TABLE** page 2 data in locations **TABLE**(32000) -**TABLE**(47999) to **FLASH** memory page 5.

```
    FLASHTABLE(1,5,2)
```

SEE ALSO:

FLASHVR

FLASHVR

TYPE:

System Function

SYNTAX:

FLASHVR(function)

DESCRIPTION:

Copies user **VR** or **TABLE** data in RAM to and from the permanent **FLASH** memory.

If **FLASHVR**(-1) is being used then you cannot use **FLASHTABLE**

PARAMETERS:

function:	Specifies the required action.	
	-1	Stores the entire **TABLE** to the Flash EPROM and use it to replace the RAM table data on power-up.
	-2	Stop using the EPROM copy of table during power-up.
	-100	Force all changed **VR**'s to be committed to Flash EPROM (non battery backed controllers only)

After using function -1, any changed table data will be overwritten on the next power up or reset.

EXAMPLE:
Save the entire **TABLE** data to **FLASH** memory.

```
    FLASHVR(-1)
```

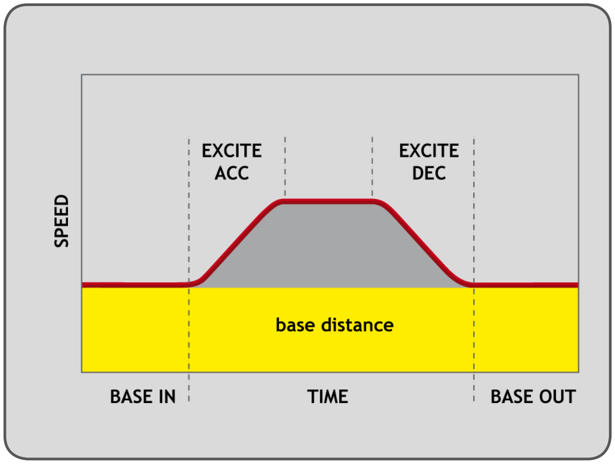
SEE ALSO:
FLASHTABLE

FLEXLINK

TYPE:
Axis Command

SYNTAX:
FLEXLINK(base_dist, excite_dist, link_dist, base_in, base_out, excite_acc, excite_dec, link_axis, options, start_pos)

DESCRIPTION
The **FLEXLINK** command is used to generate movement of an axis according to a defined profile. The motion is linked to the measured motion of another axis. The profile is made up of 2 parts, the base move and the excitation move both of which are specified in the parameters. The base move is a constant speed movement. The excitation movement uses sinusoidal profile and is applied on top of the base movement.



This command allows you to simplify a **CAMBOX** type movement through not having to use any table data.

PARAMETERS:

base_dist:	The distance the axis should move at a constant speed		
excite_dist:	The distance the axis should perform the profiled move		
link_dist:	The distance the link axis should move while the **FLEXLINK** profile executes		
base_in:	The percentage of the base move time that completes before the excitation move starts		
base_out:	The percentage of the base move time that completes after the excitation move completes.		
excite_acc:	The percentage of the excitation move time used for acceleration		
excite_dec:	The percentage of the excitation move time used for deceleration.		
link_axis:	The axis to link to.		
link_options:	Bit value options to customize how your **FLEXLINK** operates		
	Bit 0	1	link commences exactly when registration event **MARK** occurs on link axis
	Bit 1	2	link commences at an absolute position on link axis (see link_pos for start position)
	Bit 2	4	**FLEXLINK** repeats automatically and bi-directionally when this bit is set. (This mode can be cleared by setting bit 1 of the **REP_OPTION** axis parameter)
	Bit 5	32	Link is only active during a positive move on the link axis
	Bit 8	256	link commences exactly when registration event **MARKB** occurs on link axis
	Bit 9	512	link commences exactly when registration event **R_MARK** occurs on link axis. (see link_pos for channel number)
link_pos:	link_option bit 1 - the absolute position on the link axis in user **UNITS** where the **FLEXLINK** is to start. link_option bit 9 – the registration channel to start the movement on		

The link_dist is in the user units of the link axis and should always be specified as a positive distance.

The link options for start (bits 1, 2, 8 and 9) may be combined with the link options for repeat (bits 4 and 8) and direction.

start_pos cannot be at or within one servo period’s worth of movement of the **REP_DIST** position.

EXAMPLES:

EXAMPLE 1:

Suppose you want a smooth curve for 40% of a cycle and to remain stationary for the remainder:

```
    FLEXLINK(0,10000,20000,60,0,50,50,1)
```

In this example the move length is 10000 and this is linked to 20000 distance on the link axis (1). The axis is stationary for 60% of the cycle and the move is 50% accel/50% decel.

EXAMPLE 2:

Suppose you want a 1:1 background link but to advance 500 using a smooth curve between 80% and 95% of a cycle:

```
    FLEXLINK(10000,500,10000,80,5,50,50,1)
```

In this example the base move length is 10000 and this is linked to 10000 distance on the link axis (1). The excite distance is 500 and this starts after 80% of the cycle, with 5% at the end also clear of excitation. The "excite" move is 50% accel/50% decel.

FOR..TO.. STEP..NEXT

TYPE:

Program Structure

SYNTAX:

```
FOR variable = start TO end [STEP increment]
  commands
NEXT variable
```

DESCRIPTION:

A FOR program structure is used to execute a block of code a number of times.

On entering this loop the variable is initialised to the value of start and the block of commands is then executed. Upon reaching the **NEXT** command the variable defined is incremented by the specified **STEP**. If the value of the variable is less than or equal to the end parameter then the block of commands is repeatedly executed. Once the variable is greater than the end value the program drops out of the FOR.. **NEXT LOOP**.

FOR..NEXT loops can be nested up to 8 deep in each program.

PARAMETERS:

commands:	Trio **BASIC** statements that you wish to execute
variable:	A valid Trio **BASIC** variable. Either a global **VR** variable, or a local variable may be used.

start:	The initial value for the variable
end:	The final value for the variable
increment:	The value that the variable is incremented by , this may be positive or negative

The **STEP** increment is optional, if this is omitted then the **FOR NEXT** will increment by 1

The variable can be adjusted or used within the structure.

EXAMPLES:

EXAMPLE 1:

Turn ON outputs 10 to 18, using the variable to change the output.

```
FOR op_num=10 TO 18
  OP(op_num,ON)
NEXT op_num
```

EXAMPLE 2:

Index an axis from 5 to -5 using a negative **STEP**.

```
FOR dist=5 TO -5 STEP -0.25
  MOVEABS(dist)
  WAIT IDLE
  GOSUB pick_up
NEXT dist
```

EXAMPLE 3:

Using a FOR structure to move through a set of x,y positions. If there is a **MOTION_ERROR** then the variables are set to a large values so the loop no longer repeats

```
FOR x=1 TO 8
  FOR y=1 TO 6
    MOVEABS(x*100,y*100)
    WAIT IDLE
    GOSUB operation
    IF MOTIONERROR THEN
      x=10
      y = 10
    ENDIF
  NEXT y
NEXT x
```

FORCE_SPEED

TYPE:
Axis Parameter

DESCRIPTION:
This parameter sets the main speed for a motion command that supports the advanced speed control (commands ending in SP). The **VP_SPEED** will accelerate or decelerate so that the profile is completed at **FORCE_SPEED**

The lowest value of **SPEED**, **ENDMOVE_SPEED**, **FORCE_SPEED** or **STARTMOVE_SPEED** will take priority.

FORCE_SPEED is loaded into the buffer at the same time as the move so you can set different speeds for subsequent moves.

VALUE:
The speed at which the SP motion command will execute, in user **UNITS**. (default 0)

EXAMPLES:

EXAMPLE 1:
In this example the controller will ramp the speed down to a speed of 10 at the end of the **MOVE**. Then for the duration of the **MOVESP**(20) the speed will be 10, after which it will ramp back to a speed of 15.

```
SPEED = 15
MOVE(100)
FORCE_SPEED = 10
MOVESP(20)
MOVE(100)
```

EXAMPLE 2:
Use **FORCE_SPEED** to slow the profile speed down during a corner move

```
FORCE_SPEED=100
MOVESP(100,0)
FORCE_SPEED=50
MOVECIRCSP(100,100,100,0,1)
FORCE_SPEED=100
MOVESP(0,100)
```

SEE ALSO:
ENDMOVE_SPEED, STARTMOVE_SPEED

FORWARD

TYPE:
Axis Command

SYNTAX:
FORWARD

ALTERNATE FORMAT:
FO

DESCRIPTION:
Sets continuous forward movement. The axis accelerates at the programmed **ACCEL** rate and continues moving at the **SPEED** value until either a **CANCEL** or **RAPIDSTOP** command are encountered. It then decelerates to a stop at the programmed **DECEL** rate.

If the axis reaches either the forward limit switch or forward soft limit, the **FORWARD** will be cancelled and the axis will decelerate to a stop.

EXAMPLES:

EXAMPLE 1:
Run an axis forwards. When an input signal is detected on input 12, bring the axis to a stop.

FPGA_PROGRAM

TYPE:
System Function

SYNTAX:
value = FPGA_PROGRAM(program)

DESCRIPTION:
This function allows you to select between the different **FPGA** programs that are available on controllers that support **FPGA** re-programming.

Rather than using this command we recommend using the tool in *Motion* Perfect to select the **FPGA** variant.

PARAMETERS:

variant:	-1	Displays **FPGA** images stored in local controller flash memory
	>=0	The program number to load, see table below or check **FPGA_PROGRAM**(-1) to see available options.
value:	**TRUE**	**FPGA** programmed successfully

MC403:

FPGA_PROGRAM	FEATURES	NOTES
0	Servo, Stepper, **HW_PSWITCH**, SSI	Default program
1	Servo, Stepper, **HW_PSWITCH**, Tamagawa	
2	Servo, Stepper, **HW_PSWITCH**, EnDAT	**HW_PSWITCH** only available on first 2 axes

MC405:

FPGA_PROGRAM	FEATURES	NOTES
0	Servo, Stepper, **HW_PSWITCH**, SSI, Tamagawa	Default program
1	Servo, Stepper, **HW_PSWITCH**, SSI, EnDAT	
2	Reserved	

EXAMPLE:

Check the available **FPGA** programs then load program 1 so that an EnDAT encoder can be used. Do not forget to power cycle.

```
>>FPGA_PROGRAM(-1)
0 : (00C) Servo,Stepper,PSwitch,SSI,Tamagawa
1 : (00C) Servo,Stepper,PSwitch,SSI,EnDAT
>>FPGA_PROGRAM(1)
>>
```

SEE ALSO:

FPGA_VERSION

FPGA_VERSION

TYPE:

Slot Parameter

DESCRIPTION:

Using the **SLOT** modifier on the MC464 enables checking of the **FPGA** version number in the main controller and any of the expansion modules.

On controllers that support **FPGA** re-programming, the version number is split to display the main version number and program loaded.

VALUE:

On the MC464 it displays the **FPGA** version of the specified **SLOT**

On controllers that support **FPGA** variants the **FPGA** returns the following:

Bit	Description	Function
0 - 7	**FPGA** version number	Unique version number for this **FPGA** program
8 - 14	**FPGA** program	The currently installed **FPGA_PROGRAM**

Bits 8-14 return a number that is one higher than the one you use in **FPGA_PROGRAM**

EXAMPLE:

Check the currently installed **FPGA** program and its version number on the command line. The result shows that **FPGA** program 1 is installed and the version is 0C.

```
>>PRINT HEX(FPGA_VERSION)
10C
>>
```

SEE ALSO:

FPGA_PROGRAM, SLOT

FPU_EXCEPTIONS

TYPE:

Reserved Keyword

FRAC

TYPE:

Mathematical Function

SYNTAX:

```
value = FRAC(expression)
```

DESCRIPTION:

Returns the fractional part of the expression.

PARAMETERS:

value:	The fractional part of the expression
expression:	Any valid TrioBASIC expression

EXAMPLE:

Print the fractional part of 1.234 on the command line

```
>>PRINT FRAC(1.234)
0.2340
>>
```

FRAME

TYPE:

Axis Parameter

DESCRIPTION:

A **FRAME** is a transformation which enables the user to program in one coordinate system when the machine or robot does not have a direct or one-to-one mechanical connection to this coordinate system.

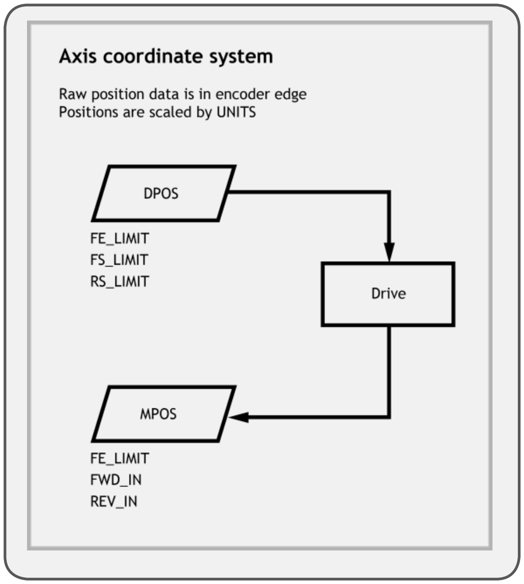
The **FRAME** command selects which transformation to use on axes in a **FRAME_GROUP**. Applying a **FRAME** to an axis in a **FRAME_GROUP** will apply that frame to all the axes in the group. To make this compatible with older firmware, if no FRAME_GROUPs have been configured then a default group is generated using the lowest axes, regardless of what axis the **FRAME** parameter was issued on.

Most transformations require configuration data to specify the lengths of mechanical links or operating modes. This is stored in the table with offsets detailed below in the parameters list. These table positions are offset by the ‘table_offset’ parameter in **FRAME_GROUP**. For a default **FRAME_GROUP** table_offset is 0.

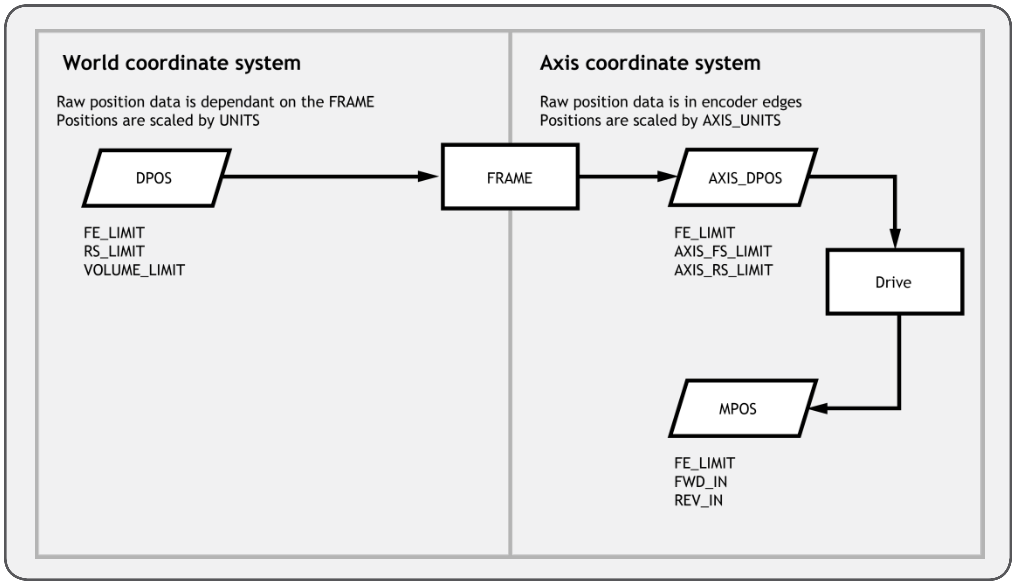
Do not change the **FRAME TABLE** parameters with the **FRAME** enabled. This can result in unpredictable movement which could cause damage or harm.

The kinematic runtime feature enable code is required to run **FRAME** 14 and higher

SYSTEM WITH FRAME=0



SYSTEM WITH FRAME<>0



AXIS SCALING

When a **FRAME** is enabled **UNITS** applies the scaling to the world coordinate system and **AXIS_UNITS** applies scaling to the axis coordinate system.

When **FRAME** is enabled **MPOS** is scaled by **AXIS_UNITS**, when frame is disabled **MPOS** is scaled by **UNITS**.

POSITION AND FOLLOWING ERRORS

When a **FRAME** is active **MPOS** is the motor position and **DPOS** is in the world coordinate system. **AXIS_DPOS** can be read to find the demand position in the motor coordinate system.

The following error is calculated between **MPOS** and **AXIS_DPOS** and so is the following error of the motor.

When using multiple frames or if you wish to group your axis you can use **DISABLE_GROUP** so that a **MOTION_ERROR** on one axis does not affect all.

HARDWARE AND SOFTWARE LIMITS

As **FS_LIMIT** and **RS_LIMIT** use **DPOS** they are both active in the world coordinate system. **VOLUME_LIMIT** also uses **DPOS** so is also in the world coordinate system. **FWD_IN** and **REV_IN**, **AXIS_FS_LIMIT** and **AXIS_RS_LIMIT** use **AXIS_DPOS** as so act on the forward and reverse limit of the motor.

When moving off **FWD_IN** and **AXIS_FS_LIMIT** the motor must move in a reverse direction. Due to the **FRAME** transformation this may not be a reverse movement in the world coordinate system. When moving off a **REV_IN** and **AXIS_RS_LIMIT** the motor must move in a forward direction. Due to the **FRAME** transformation this may not be a forward movement in the world coordinate system.

OFFSETTING POSITIONS

When a **FRAME** is enabled **OFFPOS** and **DEFPOS** must not be used as they cause a jump in both **DPOS** and **MPOS**. As the transformation separates **DPOS** and **MPOS** using these commands will cause an undesirable jump in motor position.

REP_DIST also causes a jump in **DPOS** and **MPOS** so when using a **FRAME** the position must never reach **REP_DIST**. **REP_OPTION** must be set to 0 and **REP_DIST** must be at least twice the size of the biggest possible move on the system.

When **DATUM** is complete it also causes a jump in **DPOS** and **MPOS**, so **DATUM** must never be used when **FRAME** <> 0

You can use **USER_FRAME** to define a different origin to program from.

POWER ON SEQUENCE AND HOMING

Some **FRAME** transformations require the machine to be homed and/ or moved to a position before the **FRAME** is enabled. This can be done using the **DATUM** function. If you home position is not the zero position of the **FRAME** then you can use **DEFPOS**/ **OFFPOS** to set the correct offset before enabling the **FRAME**.

When a **FRAME** is enabled **DPOS** is adjusted to the world coordinates which are calculated from the current **AXIS_DPOS**.

You should not perform a **DATUM** homing routine when the **FRAME** is enabled as this will change the **DPOS** which may result in undesirable motion. If you need to perform homing when the **FRAME** is enabled you can move to a registration position and then use **USER_FRAME** to apply the offset.

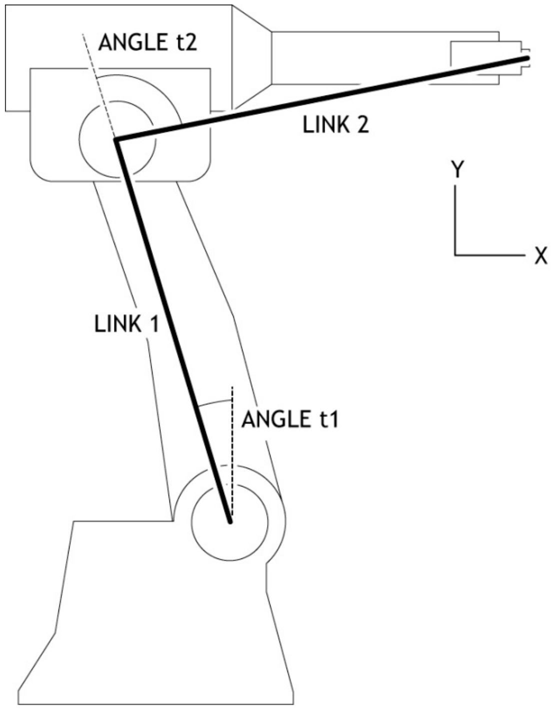
VALUE:

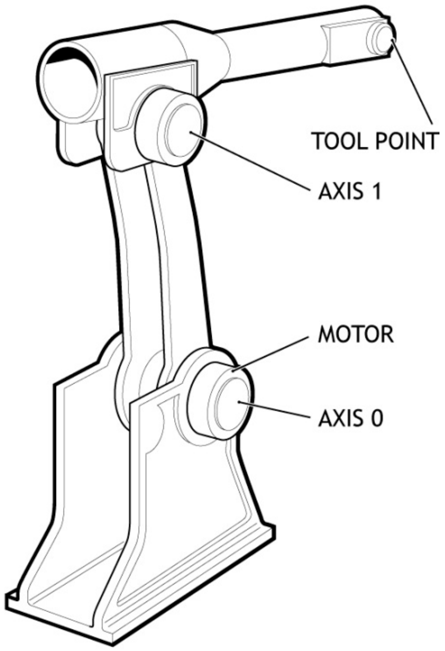
0	No transform
1	2 axis **SCARA** robot
2	XY single belt
5	2 axes rotation
6	Polar to Cartesian transformation
10	Cartesian to polar transformation
13	Dual arm robot transformation
14	3 arm delta robot.
15	4 axis **SCARA**
16	3 Axis Robot with 2 Axis Wrist
17	Wire guided camera
18	6 axis articulated arm
114	3 arm delta robot.
115	3 to 5 axis **SCARA**
116	3 Axis Robot with 2 Axis Wrist
119	3 to 5 axis cylindrical robot with 2 Axis Wrist

FRAME=1, 2 AXIS SCARA

DESCRIPTION:

Frame=1 allows the user to program in X, Y, Cartesian coordinates for a 2 axis **SCARA** arm like the example below. The frame allows for 2 configurations of a **SCARA** depending if the second axis motor is in the joint or at the base. The difference is that in angle t2 is referenced from link 1, or t2 is referenced from the base. A linkage or belt is typically used to keep t2 referenced to the base.





Second motor is carried on the end of Link 1, t2 is relative to link 1

Second motor in base with link arm to move upper part, t2 is relative to the base

Once the frame is enabled **DPOS** is measured in Micrometres, **UNITS** can then be set to a convenient scale.

HOMING

Is it required that the 2 motors' absolute positions are homed relative to the "straight up" position before the **FRAME** is enabled. In other words, the zero angle on each axis is with the arms in line and vertical. Of course it is not necessary for the motors to actually go to this position as you can offset the position using **DEFPOS** or **OFFPOS**.

JOINT CONFIGURATION

The joint configuration is determined by the position of the **SCARA** arm when you enable **FRAME** = 1

The joint is defined as Right Handed if:

(t2<t1) –both motors in base

(t2<0) –motors in the joint

Otherwise the robot is Left handed

PARAMETERS:

Table data	0	Length of arm 1 in micrometres
	1	Length of arm 2 in micrometres
	2	Edges per radian for joint 1
	3	Edges per radian for joint 2
	4	Internal value. Set to 0 to force frame re-calculation
	5	Axis configuration:
		0 – Both motors fixed in base
		1 – Motors at the joint
	6	Joint configuration (read only):
		0 – Left handed **SCARA**
		1 – Right handed **SCARA**
	7	used internally
	8	used internally

EXAMPLES:

EXAMPLE 1:

Set up the **SCARA** arm which is configured with the motors in the joints. Both motors return 16000 counts per revolution. The robot can be homed to switches which are at -80 degrees and +150degrees for the two joints. After setting **FRAME**=1 the tip of the second arm will be set with X, Y as (0,42426). This effectively makes the (0,0) XY position to be the bottom joint of the lower arm.

All the normal move types can then be run within the **FRAME**=1 setting until it is reset by setting **FRAME**=0. As the **FRAME** 1 makes the resolution of axes 0 and 1 micrometres, the **UNITS** can be set so you can program in mm.

```
FRAME=0

'Enter Configuration Parameters:
TABLE(0, 300000) '    Length of arm 1 in mm * 1000
TABLE(1, 445000) '    Length of arm 2 in mm * 1000
TABLE(2, 16000/(2*PI)) ' edges per radian for joint 1
TABLE(3, 16000/(2*PI)) ' edges per radian for joint 2
TABLE(4, 0) ' Internal value. Set to 0 to force frame re-calculation
TABLE(5, 1) ' set to 1 for second joint fixed to arm 1

'Home the robot to its mechanical limit switches
DATUM(3) AXIS(0) ' find home switch for lower part of arm
WAIT IDLE
```

```
DATUM(3) AXIS(1) ‘ find upper arm home position
WAIT IDLE

‘The mechanical layout may make it impossible to home at (0,0)
‘Define the home position values as their true angle (in edges)
DEFPOS(-3555,6667) ‘ say home position is -80 deg and +150 deg
WAIT UNTIL OFFPOS=0

‘Move both arms to start position PI/4 radians (45 degrees)
MOVEABS(-TABLE(2)*0.7854,TABLE(3)*0.7854*2)
WAIT IDLE

FRAME=1

UNITS AXIS(0)=1000
UNITS AXIS(1)=1000
```

EXAMPLE 2:

Set up the table for **SCARA** arm which is configured with both motors in the base. Once the table is configured the rest of the initialisation is the same as the above example.

```
‘ Enter Configuration Parameters:
TABLE(0,400000) ‘         Link 1 in mm * 1000
TABLE(1,250000) ‘         Link 2 in mm * 1000
TABLE(2, 4096*5/(2*PI)) ‘ t1 in edges per radian
TABLE(3, 4096*3/(2*PI)) ‘ t2 in edges per radian
TABLE(4,0) ‘ Internal value. Set to 0 to force frame re-calculation
TABLE(5,0) ‘ set to 0 for second joint fixed to base
```

FRAME=2, XY SINGLE BELT

DESCRIPTION:

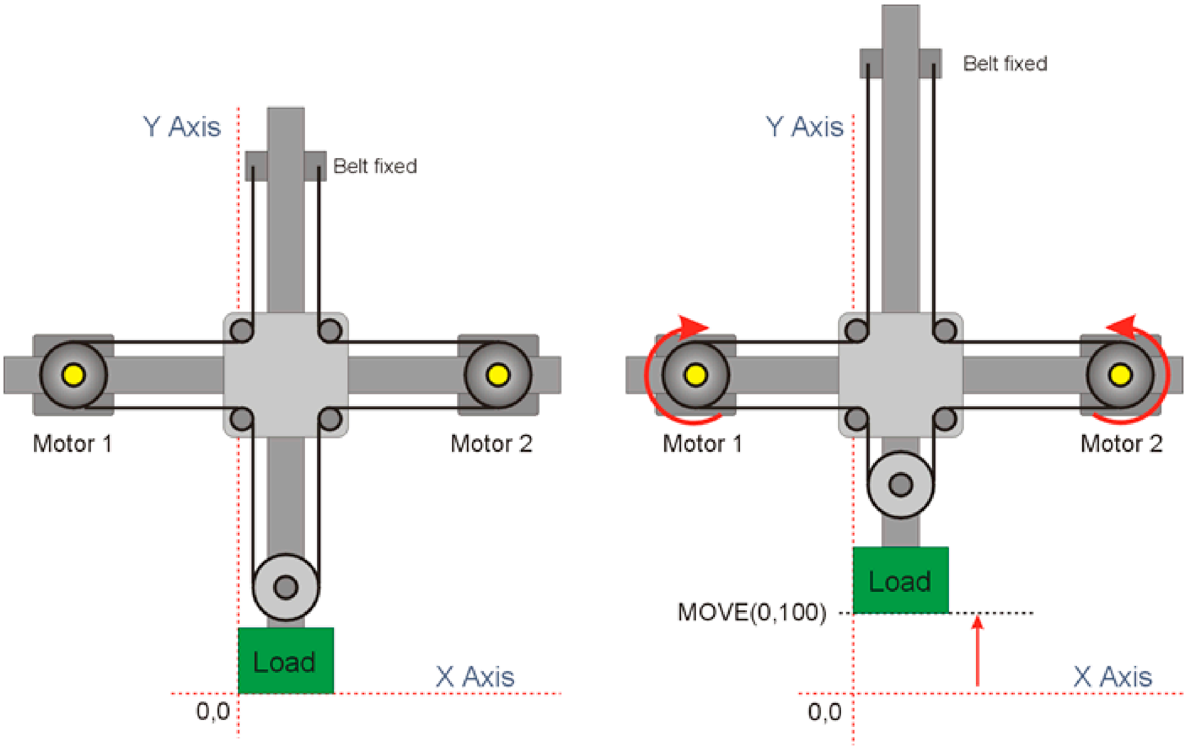
Switching to **FRAME**=2 will allow X-Y motion using a single-belt configuration. In this mode, an interpolated move of **MOVE**(0,100) produces motion on both motor 1 and motor 2 to raise the load vertically, based on the transformed position. Note that the two motors are located on the X-axis. The mass of the Y-axis can be minimized in this configuration. The equations for the transformed position of the X and Y axes are as follows:

Xtransformed = (**MPOS AXIS**(0)+ **MPOS AXIS**(1))*0.5

Ytransformed = (**MPOS AXIS**(0)- **MPOS AXIS**(1))*0.5

The transformed X-Y coordinates are derived from the measured encoder position (**MPOS**) of **AXIS**(0) and **AXIS**(1). This conversion is automatically accomplished by the *Motion Coordinator* when **FRAME**=2.

Once the frame is enabled **DPOS** is measured in encoder counts, **UNITS** can be set to enable a more convenient scale.



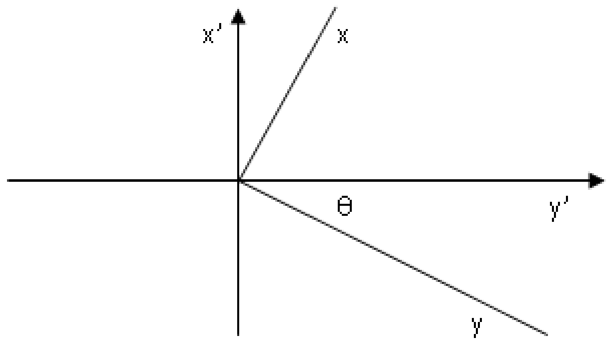
EXAMPLE:

```
ATYPE=0 'disable built in axes for MC464

FRAME=0

'Define a start position
DEFPOS(150,50)
FRAME=2
```

FRAME=5, 2 AXES ROTATION

DESCRIPTION:

This frame is designed to allow two orthogonal axes to be “turned” through an angle so that command inputs to x, y (along the required plane) are transformed to the fixed axes x’ and y’.



The transform is done by way of a 2 x 2 matrix, the coefficients of which can be easily derived from the required rotation angle of the operating plane.

CALCULATING THE MATRIX COEFFICIENTS:

For the frame to work, 2 sets of matrix coefficients must be entered, one for the forward transform and the second for the inverse. The transform calculates x and y according to the following:

```
    (x’, y’) = (x, y) * ⎛TABLE(0), TABLE(1)ö
                        ⎝TABLE(2), TABLE(3)∅
```

The inverse transform is calculated thus:

```
    (x, y) = (x’, y’) * ⎛TABLE(4), TABLE(5)ö
                        ⎝TABLE(6), TABLE(7)∅
```

HOMING:

The axes should be datumed in **FRAME**=0. Once this is done, then the frame can be set to 5 and move commands directed at either axis or at both axes together in the usual way. However the actual movement of x’ and y’ (the real axes) will be according to the transform.

If the axes need to be re-positioned according to the real axes, the frame can be turned off simply by setting **FRAME**=0. When this is done, the **DPOS** values will change to be the same as the **MPOS** positions, i.e. they become the positions in the x’ / y’ plane. The axes can then be moved to a new starting position and the frame set back to 5, perhaps with a new angle set.

PARAMETERS:

Table data	0	COS(theta)
	1	-SIN(theta)
	2	SIN(theta)
	3	COS(theta)
	4	**TABLE**(3) / det
	5	-**TABLE**(1) / det
	6	-**TABLE**(2) / det
	7	Table(0) / det

theta, the angle of rotation is in radians.

det = (**TABLE**(0) * **TABLE**(3)) - (**TABLE**(2) * **TABLE**(1))

EXAMPLE:

Configure a rotation of 45 degrees and run a move on the new X Y axes.

```
    x_axis = 0
    y_axis = 1

    theta_degrees = 45 'Rotation angle in degrees
    theta = theta_degrees * (2*PI/360) 'Convert to radians
    GOSUB calc_matrix
    FRAME = 5

    BASE(x_axis)
    MOVE(xdist, ydist)
    WAIT IDLE

    STOP

    '================================================
    ' Calculate the matrix parameters for FRAME 5
    ' Transform (x, y) * (TABLE(0), TABLE(1) )
    '                    (TABLE(2), TABLE(3) )
    '
    ' Inverse Transform:
    '         (x', y') * (TABLE(4), TABLE(5) )
    '                    (TABLE(6), TABLE(7) )
```

```
'==================================================
calc_matrix:
'Forward transform
TABLE(0, COS(theta))
TABLE(1, -SIN(theta))
TABLE(2, SIN(theta))
TABLE(3, COS(theta))

'Inverse transform
det = (TABLE(0) * TABLE(3)) - (TABLE(2) * TABLE(1))
TABLE(4, TABLE(3) / det)
TABLE(5, -TABLE(1) / det)
TABLE(6, -TABLE(2) / det)
TABLE(7, TABLE(0) / det)
RETURN
```

FRAME=6, POLAR TO CARTESIAN TRANSFORMATION

DESCRIPTION:

This transformation allows the user to program in polar (radius, angle) coordinates and the actual axis to move in a Cartesian (X, Y) coordinate system.

The first axis in the frame group is the Radius, the second is the angle. .

Once the frame is enabled the raw position data (**UNITS**=1) is measured in encoder counts for the radius axis and radians*scale for the angle, **UNITS** can then be set to a convenient scale. The origin for the robot is the zero position for the Cartesian system. The zero angle position is along Axis 0.

PARAMETERS:

Table data	0	Scale (counts per radian) for the rotary axis

EXAMPLES:

EXAMPLE 1:

A gantry robot has 2 axis configured in an X, Y configuration. For ease of programming the user would like to program in Polar coordinates. Both axes return 4000 counts per revolution. The **AXIS_UNITS** are set so that the axis coordinate system is in mm, the **UNITS** are set so that the World coordinate system is in mm and degrees.

```
scale = 1000000
UNITS AXIS(0) = 4000 'To program in mm
AXIS_UNITS AXIS(0) = 4000
UNITS AXIS(1) = scale*2*PI/360 'to program in degrees
AXIS_UNITS AXIS(1) = 4000
TABLE(0, scale) 'Set resolution for the angle axis
FRAME = 6
```

EXAMPLE 2:

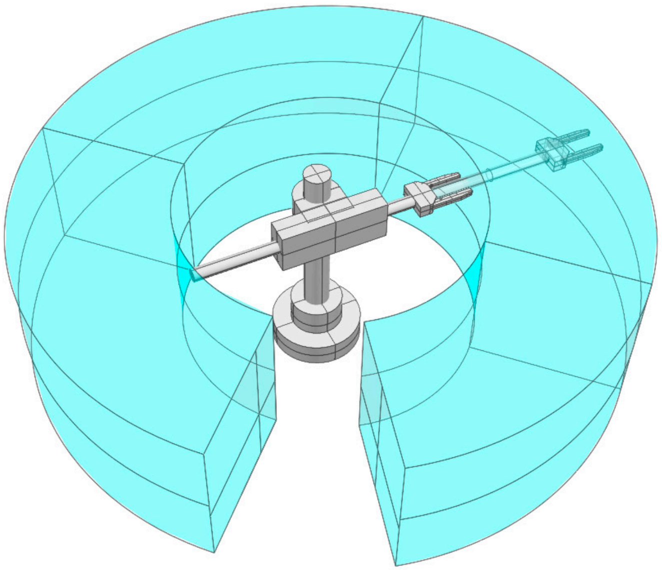
Using the robot configured in example 1 move the tool to 150mm along the X axis, then move the tool in a circle around the Polar coordinate system origin.

```
        MOVEABS(150,0)
        MOVE(0,360)
```

FRAME=10, CARTESIAN TO POLAR TRANSFORMATION

DESCRIPTION:

This **FRAME** transformation allows the user to program in Cartesian (X,Y) coordinates on a system that moves in a Polar (radius, angle) coordinate system. This is typically used on cylindrical robots where you need to program the arm extension (radius) and angle. The vertical Z axis can be simply added to make a 3 degree of freedom system.



Once the frame is enabled the raw position data (**UNITS**=1) is scaled the same for the X and Y axes, the resolution is set from the radius axis. **UNITS** can then be set to a convenient scale. The origin is the centre of the Polar system. .

The first axis in the group controls the radius axis and the second controls the rotary axis.

HOMING

Before enabling **FRAME**=10 the axes must be homed so that they are at a known position. When the **FRAME** is enabled the X and Y positions are calculated from the current Polar position.

Take care when executing moves that go close to the origin. Moves that travel through the origin will require infinite speed and acceleration. This is usually not possible to achieve and the axes will trip out due to excessive following error.

PARAMETERS:

Table data	0	Encoder edges/radian
	1	Number of revolutions, set by firmware
	2	Previous servo cycle’s angle, set by firmware

EXAMPLE:

A cylindrical robot has 3 axis which extend the arm (radius), rotate the arm (angle) and move the up and down (Z). The radius and Z axes have 4000 counts per mm, this is used for the scale of the Cartesian axes in the **FRAME**. The rotate axis has 4000 counts per revolution, this should be divided by 2*PI to give the counts per revolution which is set in the table. The **UNITS** are set so that the Cartesian system can be programmed in mm, the **AXIS_UNITS** is set so that the axis are programmed in mm or degrees. Once the polar system has been homed the following code can be executed so that any further motion is programmed in Cartesian coordinates.

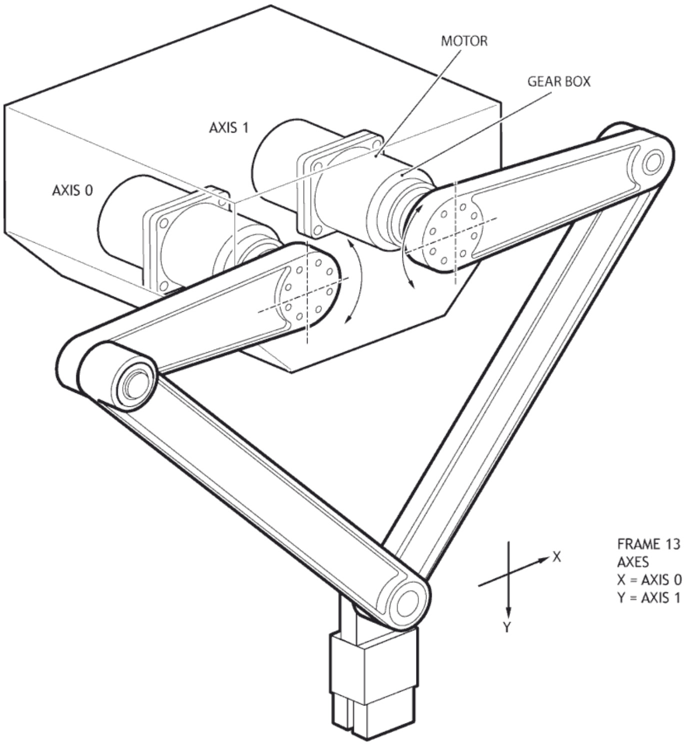
```
UNITS AXIS(0) = 4000 ‘To use in mm
AXIS_UNITS AXIS(0) = 4000 ‘To use in mm
edges_per_radian = 4000/(2*PI) ‘Edges per radian for the rotary axis
UNITS AXIS(1) = 4000’To use in mm
AXIS_UNITS AXIS(1) = 4000 / 360 ‘To use in mm
TABLE(0,edges_per_radian)
UNITS AXIS(2) = 4000 ‘To use in mm
FRAME = 10
```

FRAME=13, DUAL ARM PARALLEL ROBOT

DESCRIPTION:

Frame 13 enables the transformation for a 2 arm parallel robot as shown. It is then possible to program in X Y Cartesian coordinates.

If the lower link is not directly connected as per the image but is separated, this is compensated for by decreasing the centre distance of the top link by the same amount.

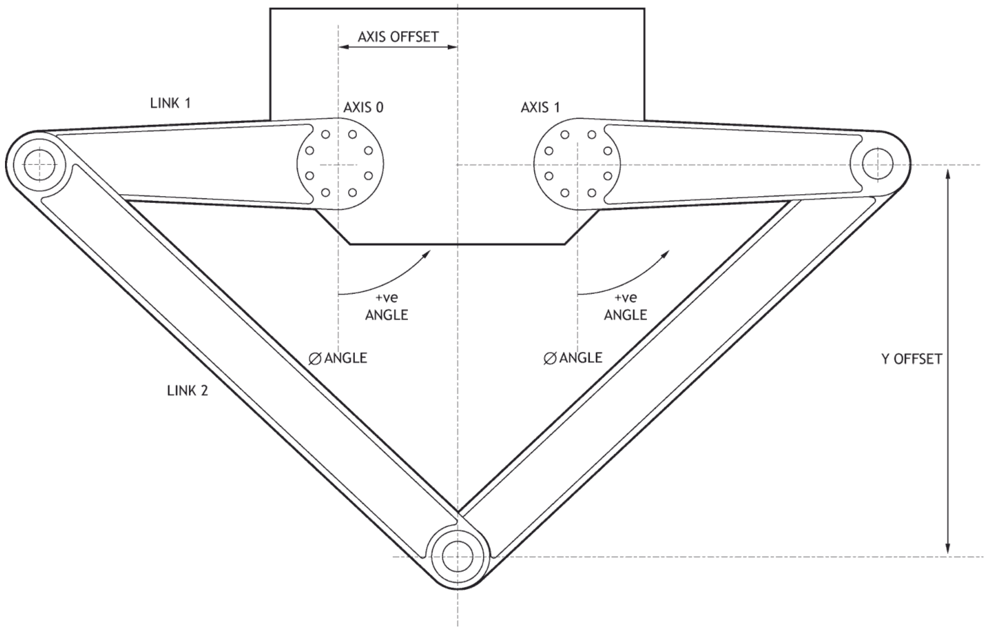


Once the frame is enabled the raw position data (**UNITS**=1) is measured in Micrometres, **UNITS** can then be set to a convenient scale.

HOMING

The 2 arm delta robot should be homed so that the two link 1's are vertical down. You do not need to enable the frame in this position, just ensure that it has been defined.

A vertical offset for the tool can be defined within the **FRAME** table data. This means that you can set the zero position vertically



PARAMETERS:

Table data	0	Link length 1 in microns
	1	Link length 2 in microns
	2	Encoder edges/radian axis 0
	3	Encoder edges/radian axis 1
	4	Horizontal offset axes from x datum
	5	Set Vertical datum with arms straight out
	6	calculated values
	7	calculated values
	8	calculated values
	12	first axis frame calculated value

EXAMPLE

The following is a typical startup program for **`FRAME`** 13.

```
FRAME=0
WA(10)
'------------------------------------------------
TABLE(0,220000)'Arm
TABLE(1,600000)'Forearm
TABLE(2,(2048*4*70)/2/PI)'pulse/radian
TABLE(3,(2048*4*70)/2/PI)'pulse/radian
TABLE(4,15000)'X-offset
TABLE(5,450000)'Y-offset = 450 mm below axis 0 centre
'------------------------------------------------

' set home position for arms at +/-90 degrees
DATUM(4) AXIS(0) 'find home switch for left arm
DATUM(3) AXIS(1) 'find home switch for right arm
WAIT IDLE AXIS(0)
WAIT IDLE AXIS(1)
home_0 = -TABLE(2)*PI/2
home_1 = TABLE(3)*PI/2
BASE(0,1)
DEFPOS(home_0,home_1)

WA(10)
FRAME=13
```

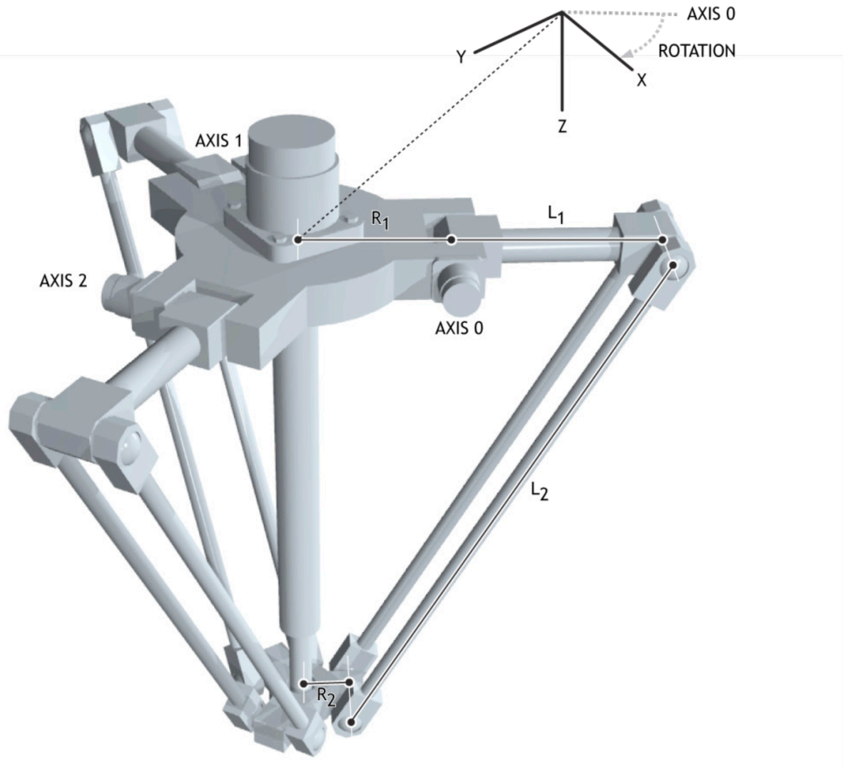
FRAME=14, DELTA ROBOT

DESCRIPTION:

FRAME=14 enables the transformation for a 3 arm ‘delta’ or ‘parallel’ robot. It transforms 3 axes from the mechanical configuration to Cartesian coordinates using the right hand rule.

For new projects **FRAME** 114 is recommended

FRAME=14 requires the kinematic runtime **FEC**



Once the frame is enabled the raw position data (**UNITS**=1) is measured in Micrometres, **UNITS** can then be set to a convenient scale. The origin for the robot is the centre of the top plate with the X direction following the first axis. This can be adjusted using the rotation parameter.

HOMING:

Before enabling **FRAME**=14 the position must be defined so that when the upper arms are horizontal the axis position is 0. You do not need to enable the frame in this position, just ensure that it has been defined.

PARAMETERS:

Table data	0	Top radius to joint in Micrometres (R1)
	1	Wrist radius to joint in Micrometres (R2)
	2	Upper arm length in Micrometres (L1)
	3	Lower arm length in Micrometres (L2)
	4	Edges per radian
	5	Angle of rotation in radians (Rotation)

EXAMPLE:

Start-up sequence for a 3 arm delta robot using the default **`FRAME_GROUP`**. Homing is completed using a sensor that detects when the upper arms are level.

```
` Define Link Lengths for 3 arm delta:
  TABLE(0,200000)’ Top radius to joint
  TABLE(1,50000)’  Wrist radius to joint
  TABLE(2,320000)’ Upper arm length
  TABLE(3,850000)’ Lower arm length

` Define encoder edges/radian
  ‘18bit encoder and 31:1 ratio gearbox
  resolution = 262144 * 31 / (2 * PI)
  TABLE(4,resolution)

` Define rotation of robot relative to global frame
  rotation = 30 ‘degrees
  TABLE(5, (rotation*2*PI )/360)

` Configure axis
  FOR axis_number=0 TO 2
    BASE(axis_number)
    ‘World coordinate system to operate in mm
    UNITS=1000
    SERVO=ON
  NEXT axis_number

  WDOG=ON
  BASE(0)

` Home and initialise frame
  ‘Arms MUST be horizontal in home position
  ` before frame is initialised.
```

```
FOR axis_number=0 TO 2
  DATUM(4)
  WAIT IDLE
NEXT axis_number

'Enable Frame
FRAME=14
```

FRAME=15, 4 AXIS SCARA

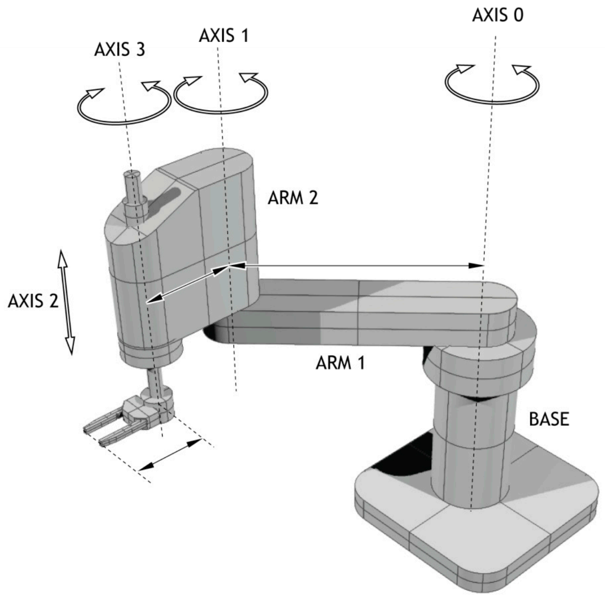
DESCRIPTION:

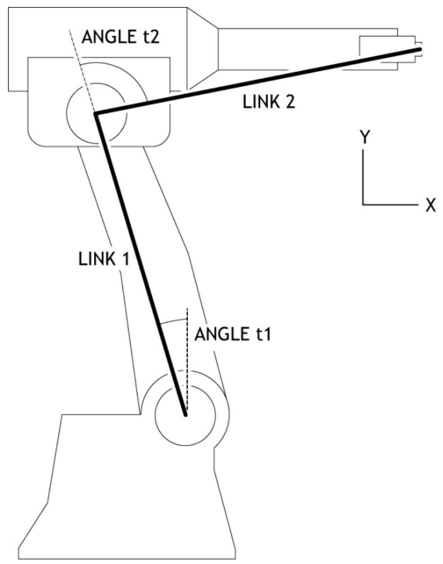
FRAME=15 enables the transformation for a 4 axis **SCARA** robot. This allows you to define the end position of the wrist in X.Y.Z and wrist angle (relative to the Y axis). The frame allows for 2 configurations of a **SCARA** depending if the second axis motor is in the joint or at the base. The difference is that the angle t2 is referenced from link 1, or the angle t2 is referenced from the base. A linkage or belt is typically used to keep t2 referenced to the base.

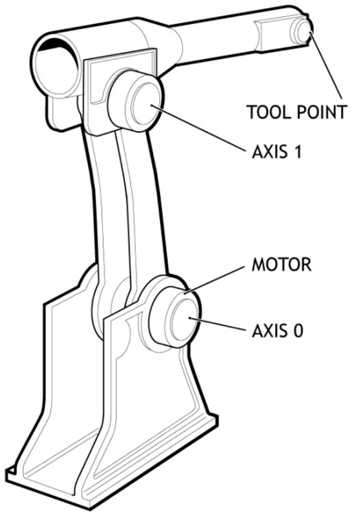
Some mechanical configurations have parasitic motion from the Z axis to the wrist angle. This can be included in the 'ratio' parameter. This is the change in encoder edges on the vertical for a change in wrist angle in encoder edges. Set this value to 0 if there is no parasitic motion.

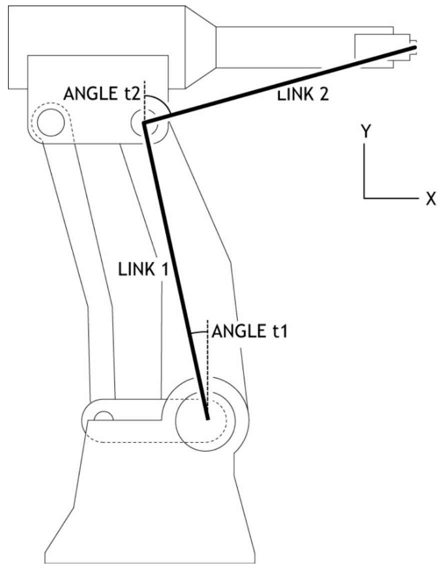
For new projects **FRAME** 115 is recommended

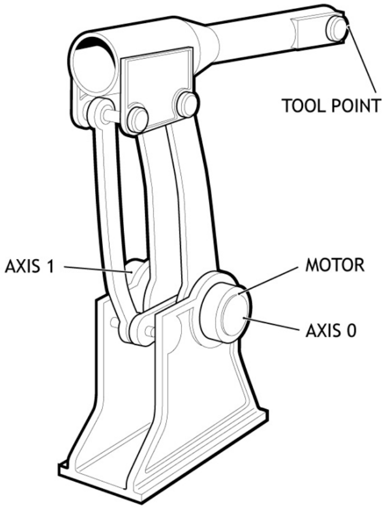
FRAME=15 requires the kinematic runtime **FEC**











Once the frame is enabled **DPOS** on the X,Y and Z axis are measured in Micrometres. The wrist axis is set to use Nanoradians. You can of course set **UNITS** for all axis to any suitable scale.

HOMING

Is it required that the X, Y and wrist absolute positions are homed relative to the “straight up” position before the **FRAME** is enabled. In other words, the zero angle on each axis is with the arms in line and vertical along the Y axis with Z=0. Of course it is not necessary for the motors to actually go to this position as you can offset the position using **DEFPOS** or **OFFPOS**.

JOINT CONFIGURATION

The joint configuration is determined by the position of the **SCARA** arm when you enable **FRAME** = 1

The joint is defined as Right Handed if:

(t2<t1) –both motors in base

(t2<0) –motors in the joint

Otherwise the robot is Left handed

PARAMETERS:

The table data values 0-8 are identical to **FRAME** 1, **SCARA**. This means you can easily switch between the 2 and 4 axis **SCARA**.

Table data	0	link1
	1	link2
	2	Encoder edges/radian axis 0
	3	Encoder edges/radian axis 1
	4	Internal value. Set to 0 to force frame re-calculation
	5	Mechanical configuration
		0 – Both motors fixed in base
		1 – Motors at the joint
	6	Joint configuration (read only)
		0 – Left handed **SCARA**
		1 – Right handed **SCARA**
	7	used internally
	8	used internally
	9	Encoder edges/radian axis 3
	10	link3
	11	Ratio of encoder edges moved on axis 2/ edge axis3
	12	Encoder edges/mm axis 2

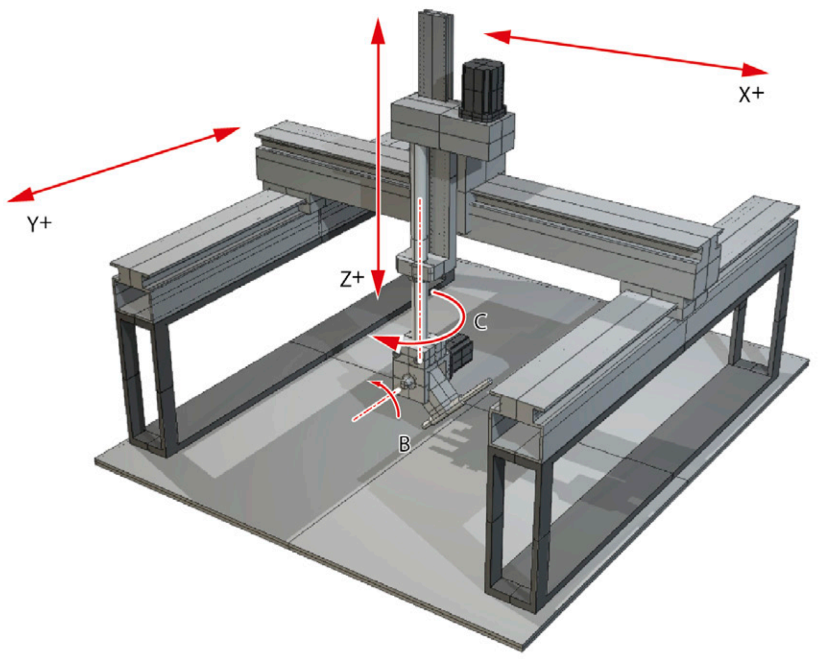
FRAME = 16, 3 AXIS ROBOT WITH 2 AXIS WRIST

DESCRIPTION:

The **FRAME** 16 transformation allows an XYZ Robot with 2 axis wrist to be easily programmed. The transformation function provides compensation in XYZ when the 2 wrist axes are rotated.

For new projects **FRAME** 116 is recommended

FRAME=16 requires the kinematic runtime **FEC**

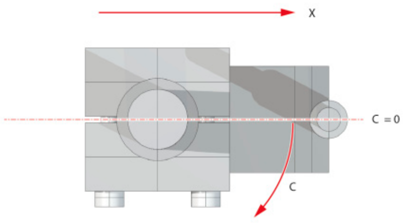


Once the frame is enabled **DPOS** on the X, Y and Z axis are measured in axis counts. The wrist axis is set to use Nanoradians. You can of course set **UNITS** for all axis to any suitable scale.

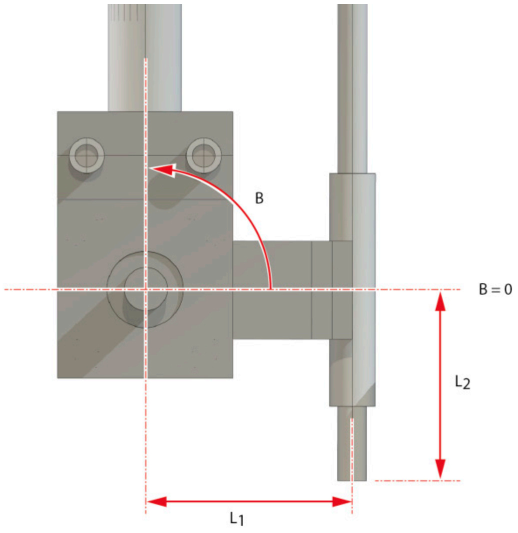
HOMING

Both wrist axes **MUST** be datumed to the correct zero position for the **FRAME** 16 transformation to operate. The zero position of the XYZ axes is not used by the transformation.

The zero position on the C axis (rotation about Z) is when the offset arm is in line with the X axis. The diagram below is drawn from above looking down on to the X-Y plane.



The zero position on the B axis(rotation about Y) is when the offset arm is the “straight down” position shown in the diagram.



The direction of motion on all 5 axes **MUST** match the diagram for the **FRAME** 16 transformation to operate.

If an axis direction of motion is inverted it can be reversed either:

Using the facility of the servo/stepper driver to invert the motion direction

On pulse direction axes using **STEP_RATIO** function inside the *Motion Coordinator*

On closed loop servo axes using **ENCODER_RATIO** / **DAC_SCALE** functions inside the *Motion Coordinator*

PARAMETERS:

Table data	0	Wrist joint to control point X offset (mm) (L1)
	1	Wrist joint to control point Z offset (mm) (L2)
	2	Wrist C axis encoder edges / radian
	3	Wrist B axis encoder edges / radian
	4	X axis encoder edges / mm
	5	Y axis encoder edges / mm
	6	Z axis encoder edges / mm

EXAMPLE:

Configure the table data for a XYZ Cartesian system with a spherical wrist.

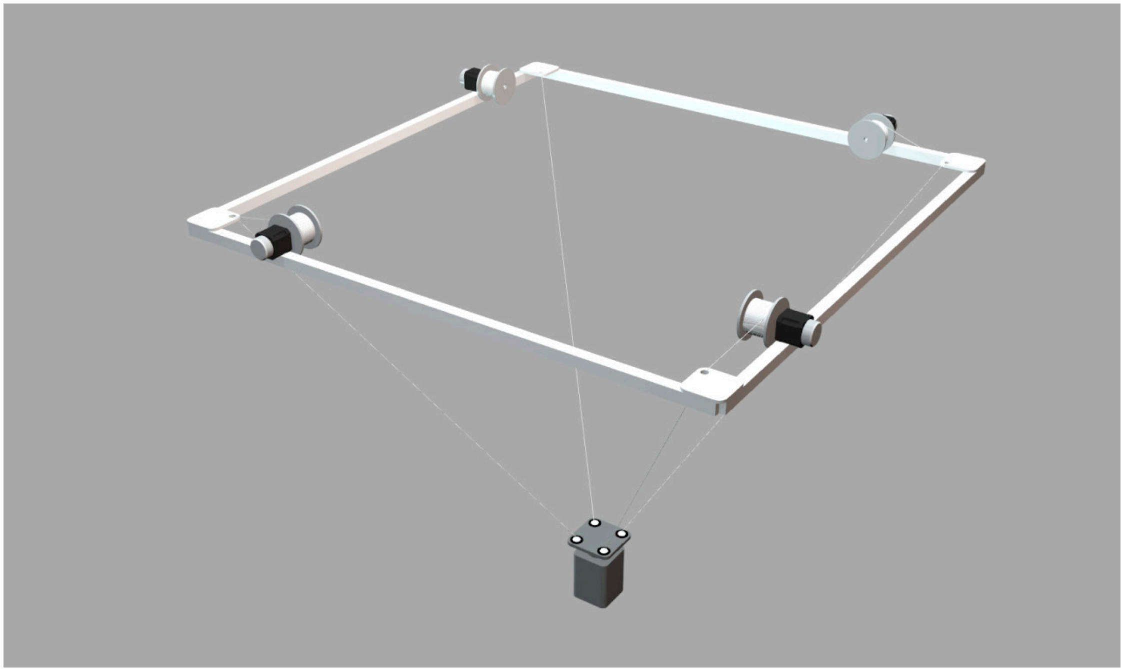
```
' Example:
' Wrist offsets: 60mm in X and 90 mm in Z
' XYZ pulses/mm 1600,1600,2560
' C and B axes pulses radian = 3200 * 16 / (2 * PI)

TABLE(100,60,90,3200 * 8 / PI, 3200 * 8 / PI,1600,1600,2560)

' Set FRAME_GROUP zero using axes 0,1,2,3,4

FRAME_GROUP(0,100,0,1,2,3,4)

FRAME=16

… program moves in XYZBC with tool angle compensation

FRAME=0

… program axes
```

FRAME=17, MULTI-WIRE CAMERA POSITIONING

DESCRIPTION:

The **FRAME** 17 transformation allows a wire mounted stadium camera to be easily programmed. The transformation function calculates the initial XYZ position of the camera using trilateration from 3 wire mounting points. During running the **FRAME** 17 calculations will calculate the wire lengths for up to 6 support wires with reels mounted in any XYZ positions.

FRAME=114 requires the kinematic runtime **FEC**



HOMING:

The length of wire related to each motor position must be known for the **FRAME** 17 transformation to operate. This requires that the wire winding drums are fitted with absolute encoders or that the system can start from a known position effectively datuming the axes.

PARAMETERS:

0	X axis position of payout position 1	User choice units
1	Y axis position of payout position 1	User choice units
2	Z axis position of payout position 1	User choice units
3	X axis position of payout position 2	User choice units
4	Y axis position of payout position 2	User choice units

5	Z axis position of payout position 2	User choice units
6	X axis position of payout position 3	User choice units
7	Y axis position of payout position 3	User choice units
8	Z axis position of payout position 3	User choice units
9	X axis position of payout position 4 (optional)	User choice units
10	Y axis position of payout position 4 (optional)	User choice units
11	Z axis position of payout position 4 (optional)	User choice units
12	X axis position of payout position 5 (optional)	User choice units
13	Y axis position of payout position 5 (optional)	User choice units
14	Z axis position of payout position 5 (optional)	User choice units
15	X axis position of payout position 6 (optional)	User choice units
16	Y axis position of payout position 6 (optional)	User choice units
17	Z axis position of payout position 6 (optional)	User choice units
18	Edges per user unit payout reel 1	Ratio (E.G. edges/mm)
19	Edges per user unit payout reel 2	Ratio (E.G. edges/mm)
20	Edges per user unit payout reel 3	Ratio (E.G. edges/mm)
21	Edges per user unit payout reel 4 (optional)	Ratio (E.G. edges/mm)
22	Edges per user unit payout reel 5 (optional)	Ratio (E.G. edges/mm)
23	Edges per user unit payout reel 6 (optional)	Ratio (E.G. edges/mm)
24	Option	0 or 1
25	Axes	3..6
26	Scale	Scale User units (see below)
27	Calculation Error	Output 0 (Error) 1 (Solution)

Payout positions: The positions (X,Y,Z) of between 3 and 6 payout positions must be specified to the calculation. These can be in the users choice of units. For example mm

Edges per user unit payout reel: These factors specify the number of encoder edges/user unit for each of the wire payout reels. The user units must be consistent with the payout positions so if the payout positions are specified in metres the edges number specified here must be edges/metre.

Option: The calculation for the camera position from 3 given lengths has 2 potential solutions. (The alternative solution normally requires negative gravity !) The Option parameter should be set to zero or 1 to give the correct solution.

Axes: A minimum of 3 wires are required. The **FRAME** 17 function will calculate the required wire lengths for between 3 and 6 payout drums. Note that the first 3 payouts only are used for calculating the starting position in **XYZ** from the 3 lengths. Where 4 or more wires are used the first 3 specified should be the most critical for the camera position.

Scale: When the **FRAME** 17 is running it calculates **INTEGER** positions in the **XYZ** space for the motion generator program inside the MC4XX. Since the user units (for example metres) are quite large distances a scale factor is required to ensure the integer positions are of fine resolution. The value should give fine resolution but the exact value is not critical. For example if the user units are metres the scale factor should be 100,000 or higher.

Calculation Error: In certain conditions (for example if the length of 1 or more wires is too short) the **FRAME** 17 calculation cannot be performed during the initial trilateration. In this case **TABLE** offset (27) is set to 0. 1 indicates a solution can be calculated.

EXAMPLE:

Test program using the **FRAME_TRANS** function to check correct operation:

```
ATYPE AXIS(0)=0
ATYPE AXIS(1)=0
ATYPE AXIS(2)=0
ATYPE AXIS(3)=0

FRAME_GROUP(1,100,0,1,2,3)

' These positions are in user units (mm for example)

TABLE(100,0,0,0)
TABLE(103,70,0,0)
TABLE(106,70,-40,0)

' 4th axis is not used to calculate starting position

TABLE(109,0,0,0)
TABLE(112,0,0,0)
TABLE(115,0,0,0)

' ratios:

ratio1=1000
ratio2=1000
ratio3=1000
ratio4=1000
```

```
    TABLE(118,ratio1,ratio2,ratio3)
    TABLE(121,ratio4,ratio5,ratio6)

    ` option:

    scale = 1000

    TABLE(124,1)'    solution option (1 or 0)
    TABLE(125,4)'    axes 3..6
    TABLE(126,1000)' scale factor

    ` These distances simulate axis positions so should be in edges:
    TABLE(200,92.195*ratio1,60*ratio2,72.111*ratio3)

    FRAME_TRANS(17,200,300,1,100)' convert wire lengths to XYZ

    PRINT TABLE(300),TABLE(301),TABLE(302)

    FRAME_TRANS(17,300,400,0,100)' convert XYZ to wire lengths

    PRINT TABLE(400)/ratio1,TABLE(401)/ratio2,TABLE(402)/ratio3,TABLE(403)/
    ratio4
```

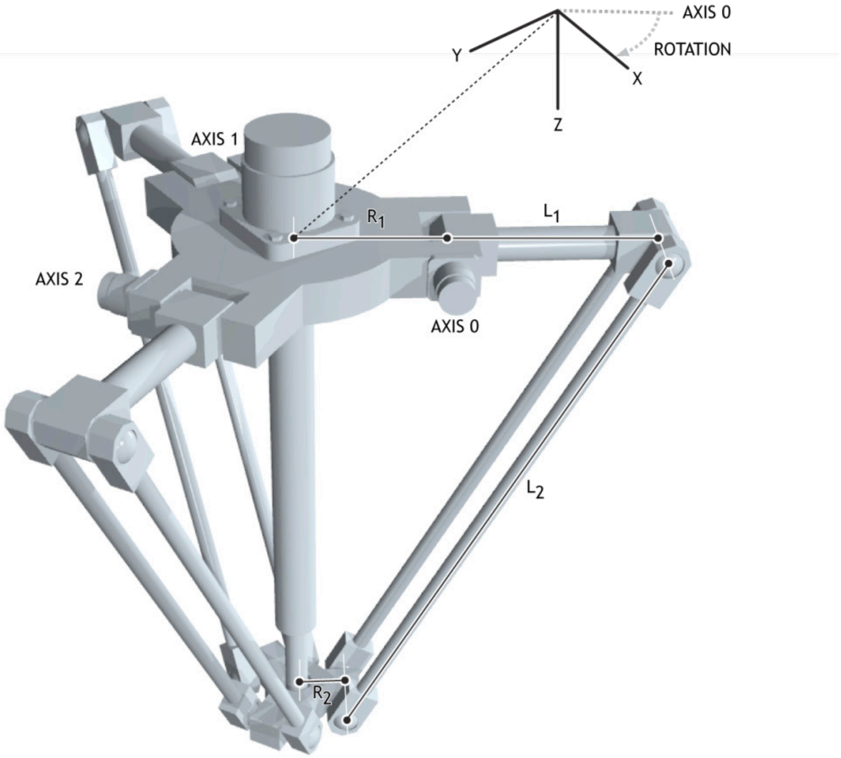
FRAME=18, 6 AXIS ARTICULATED ARM

DESCRIPTION:
Please contact Trio for details.

FRAME=114, DELTA ROBOT

DESCRIPTION:
FRAME=114 enables the high accuracy transformation for a 3 arm 'delta' or 'parallel' robot. It transforms 3 axes from the mechanical configuration to Cartesian coordinates using the right hand rule.

FRAME=114 requires the kinematic runtime **FEC**



Once the **FRAME** is enabled set the **UNITS** to **FRAME_ANGLE_SCALE** so that the Cartesian movements use the same scale as that used in the table data. So if the **TABLE** data is programmed in mm then when **UNITS** is set to **FRAME_ANGLE_SCALE** then the robot can be programmed in mm.

The origin for the robot is the centre of the top plate with the X direction following the first axis. This can be adjusted using the rotation parameter.

HOMING:

Before enabling **FRAME**=114 the position must be defined so that when the upper arms are horizontal the axis position is 0. You do not need to enable the frame in this position or even move to it, just ensure that it has been defined.

Limits:

-70 to 90 degree

PARAMETERS:

Table data	0	Top radius to joint (R1)
	1	Wrist radius to joint (R2)
	2	Upper arm length (L1)
	3	Lower arm length (L2)
	4	Edges per radian
	5	Angle of rotation in radians (Rotation)
	6	Linkx (optional with 4 or 5 axis)
	7	Linky (optional with 4 or 5 axis)
	8	Linkz (optional with 4 or 5 axis)
	9	Encoder edges/radian (optional Z rotation)
	10	Encoder edges/radian (optional Y rotation)

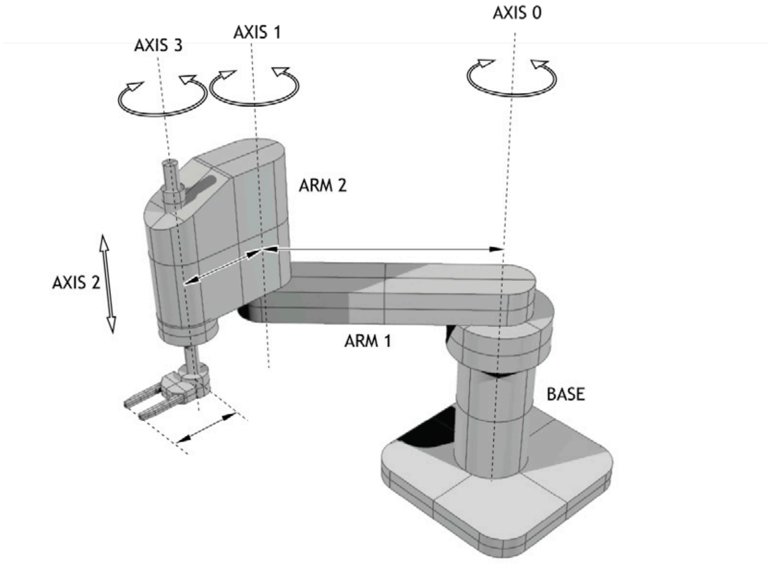
FRAME=115, 3 TO 5 AXIS SCARA

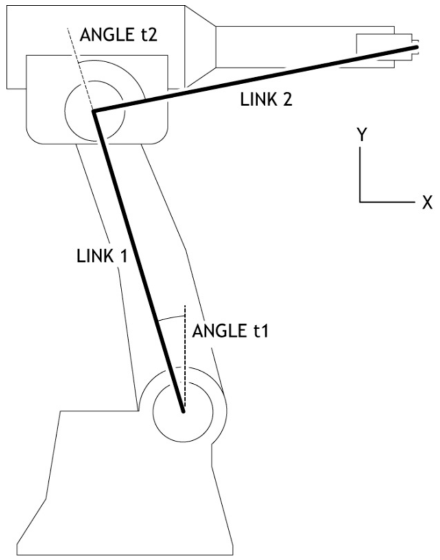
DESCRIPTION:

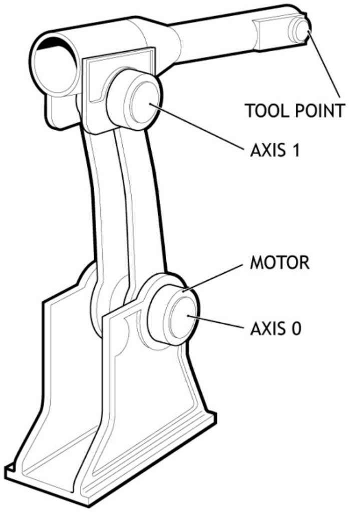
FRAME=115 enables the transformation for a 4 axis **SCARA** robot. This allows you to define the end position of the wrist in X,Y,Z and wrist angle (relative to the Y axis). The frame allows for 2 configurations of a **SCARA** depending if the second axis motor is in the joint or at the base. The difference is that the angle t2 is referenced from link 1, or the angle t2 is referenced from the base. A linkage or belt is typically used to keep t2 referenced to the base.

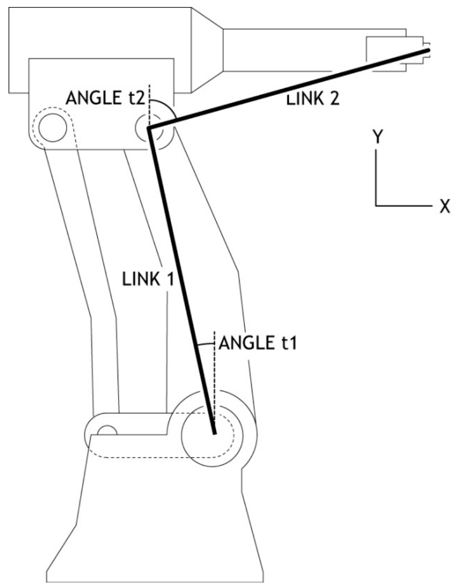
Some mechanical configurations have parasitic motion from the Z axis to the wrist angle. This can be included in the ‘ratio’ parameter. This is the change in encoder edges on the vertical for a change in wrist angle in encoder edges. Set this value to 0 if there is no parasitic motion.

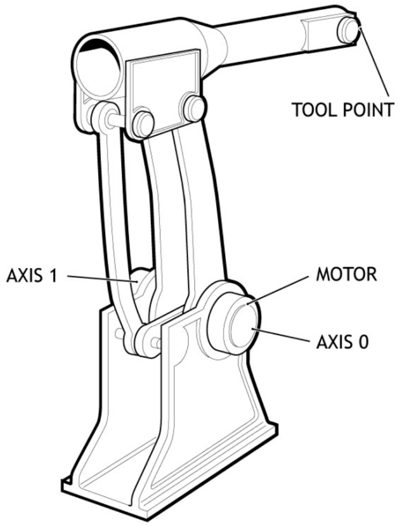
FRAME=115 requires the kinematic runtime **FEC**


AXIS 0
AXIS 1
AXIS 3
ARM 2
AXIS 2
ARM 1
BASE


ANGLE t2
LINK 2
Y
X
LINK 1
ANGLE t1


TOOL POINT
AXIS 1
MOTOR
AXIS 0





Once the **FRAME** is enabled set the **UNITS** to **FRAME_ANGLE_SCALE** so that the Cartesian movements use the same scale as that used in the table data. So if the **TABLE** data is programmed in mm then when **UNITS** is set to **FRAME_ANGLE_SCALE** then the robot can be programmed in mm.

Set the **UNITS** on the rotational (wrist) axes to **FRAME_ANGLE_SCALE** so that they are programmed in radians. You can of course set **UNITS** for all axis to any suitable scale.

HOMING

Is it required that the X, Y and wrist absolute positions are homed relative to the “straight up” position before the **FRAME** is enabled. In other words, the zero angle on each axis is with the arms in line and vertical along the Y axis with Z=0. Of course it is not necessary for the motors to actually go to this position as you can offset the position using **DEFPOS** or **OFFPOS**.

JOINT CONFIGURATION

The joint configuration is determined by the position of the **SCARA** arm when you enable **FRAME** = 1

The joint is defined as Right Handed if:

(t2<t1) –both motors in base

(t2<0) –motors in the joint

Otherwise the robot is Left handed

PARAMETERS:

The table data values 0-8 are identical to **FRAME** 1, **SCARA**. This means you can easily switch between the 2 and 5 axis **SCARA**.

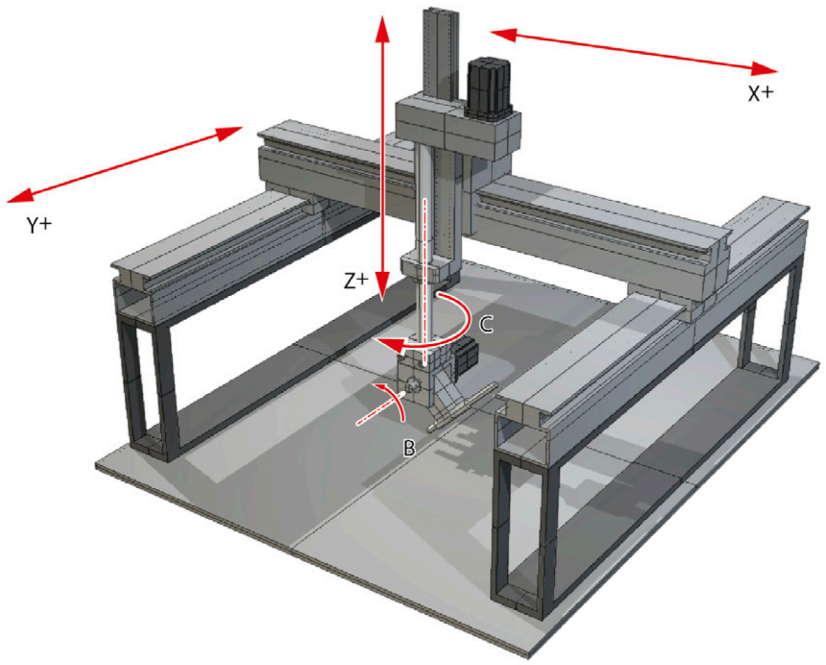
Table data	0	link1
	1	link2
	2	Encoder edges/radian axis 0
	3	Encoder edges/radian axis 1
	4	Mechanical configuration
		0 – Both motors fixed in base
		1 – Motors at the joint
	5	Joint configuration (read only)
		0 – Left handed **SCARA**
		1 – Right handed **SCARA**
	6	Encoder edges/mm axis 2
	7	Ratio of encoder edges moved on axis 2/ edge axis3
	8	Linkx (optional with 4 or 5 axis)
	9	Linky (optional with 4 or 5 axis)
	10	Linkz (optional with 4 or 5 axis)
	11	Encoder edges/radian (optional Z rotation)
	12	Encoder edges/radian (optional Y rotation)

FRAME = 116, 3 AXIS ROBOT WITH 2 AXIS WRIST

DESCRIPTION:

The **FRAME** 116 transformation allows an XYZ Robot with 2 axis wrist to be easily programmed. The transformation function provides compensation in XYZ when the 2 wrist axes are rotated.

FRAME=116 requires the kinematic runtime **FEC**

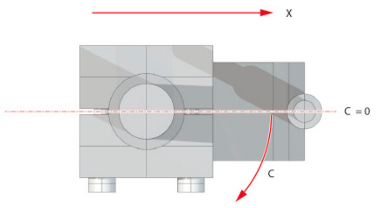


Once the **FRAME** is enabled set the **UNITS** to **FRAME_ANGLE_SCALE** so that the Cartesian movements use the same scale as that used in the table data. So if the **TABLE** data is programmed in mm then when **UNITS** is set to **FRAME_ANGLE_SCALE** then the robot can be programmed in mm.

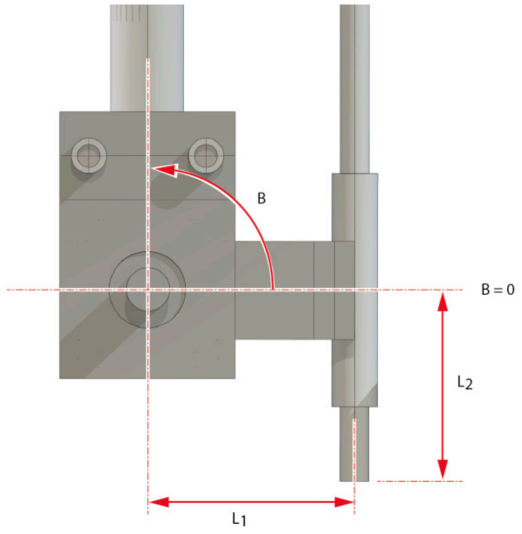
Set the **UNITS** on the rotational (wrist) axes to **FRAME_ANGLE_SCALE** so that they are programmed in radians. You can of course set **UNITS** for all axis to any suitable scale. Homing

Both wrist axes **MUST** be datumed to the correct zero position for the **FRAME** 116 transformation to operate. The zero position of the XYZ axes is not used by the transformation.

The zero position on the C axis (rotation about Z) is when the offset arm is in line with the X axis. The diagram below is drawn from above looking down on to the X-Y plane.



The zero position on the B axis(rotation about Y) is when the offset arm is the “straight down” position shown in the diagram.



The direction of motion on all 5 axes **MUST** match the diagram for the **FRAME** 116 transformation to operate.

If an axis direction of motion is inverted it can be reversed either:

Using the facility of the servo/stepper driver to invert the motion direction

On pulse direction axes using **STEP_RATIO** function inside the *Motion Coordinator*

On closed loop servo axes using **ENCODER_RATIO** / DAC_**SCALE** functions inside the *Motion Coordinator*

PARAMETERS:

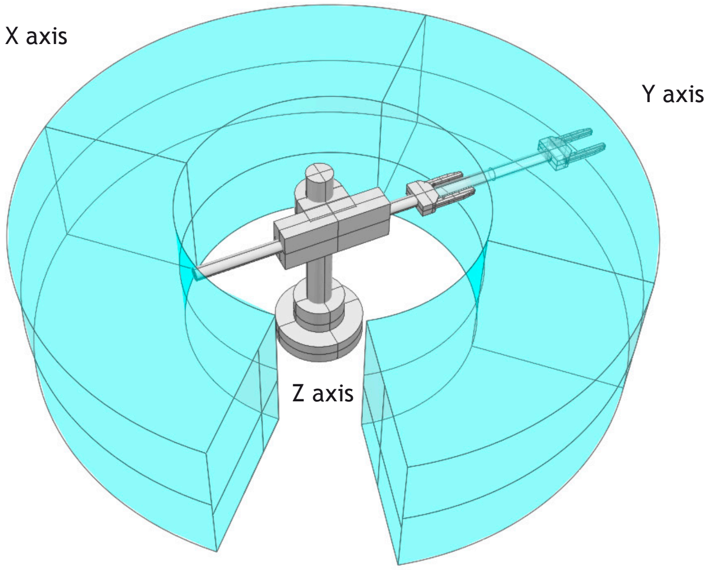
Table data	0	X axis encoder edges / mm
	1	Y axis encoder edges / mm
	2	Z axis encoder edges / mm
	3	Linkx (optional with 4 or 5 axis)
	4	Linky (optional with 4 or 5 axis)
	5	Linkz (optional with 4 or 5 axis)
	6	Encoder edges/radian (optional Z rotation)
	7	Encoder edges/radian (optional Y rotation)

FRAME 119

DESCRIPTION:

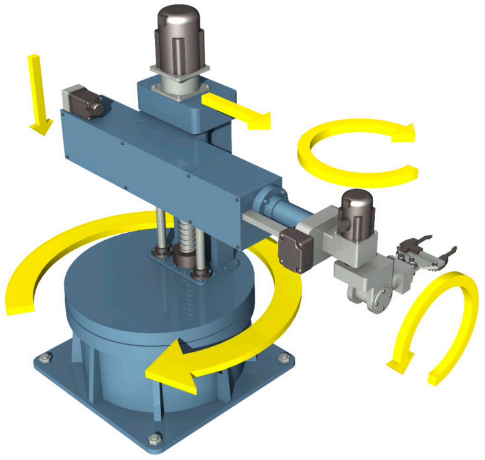
`FRAME`=119 enables the high accuracy transformation for a 3 axis cylindrical robot with a 2 axis wrist. It has optionally 3 to 5 axes which can be set by **`FRAME_GROUP`**.

`FRAME`=119 requires the kinematic runtime **`FEC`**



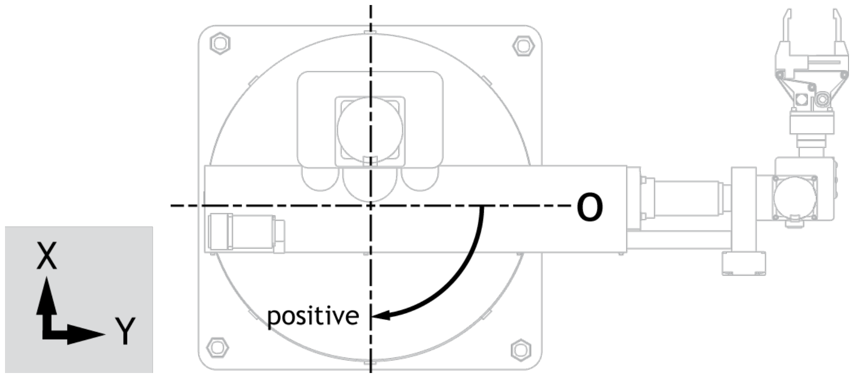
Once the **FRAME** is enabled set the **UNITS** to **FRAME_ANGLE_SCALE** so that the Cartesian movements use the same scale as that used in the table data. So if the **TABLE** data is programmed in mm then when **UNITS** is set to **FRAME_ANGLE_SCALE** then the robot can be programmed in mm.

The origin for the robot is the centre of the rotation axes.



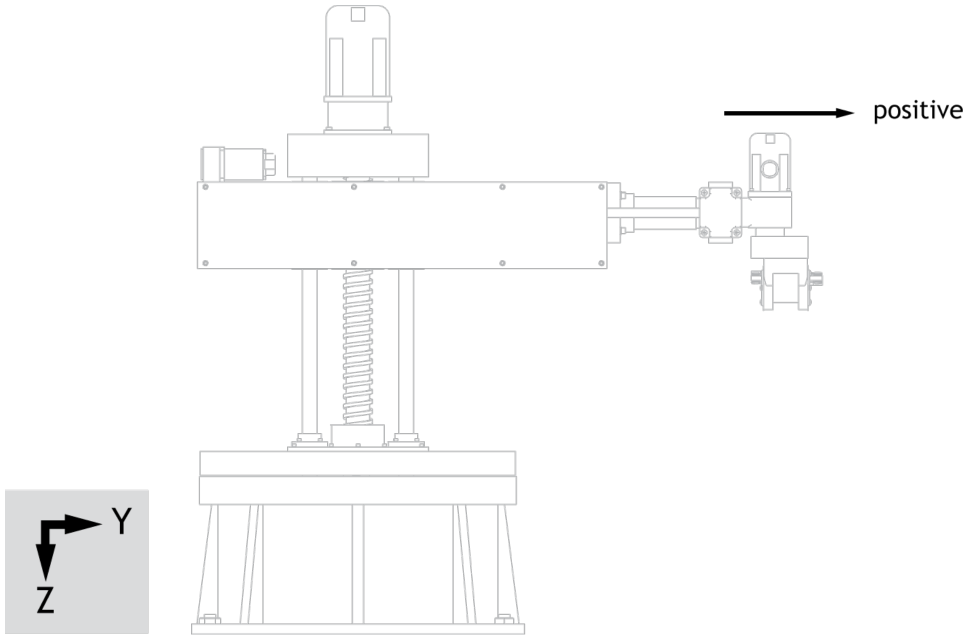
HOMING:

AXIS(0) – BASE ROTATION



Home so that the zero position is along the y axis
Positive direction is clockwise looking from above

AXIS(1) – ARM EXTENSION



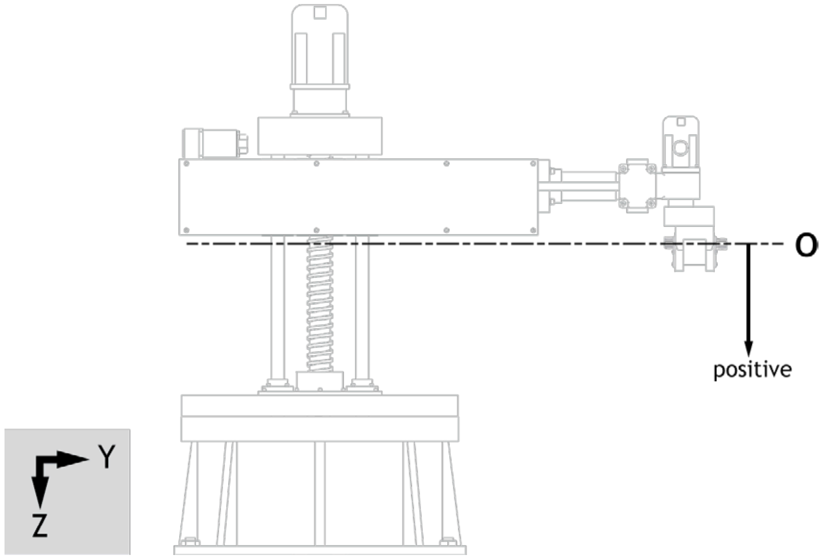
Home with arm at shortest position. Use **DEFPOS** to define the offset from the centre of rotation to the wrist

Positive direction is moving away from centre

Range: greater than zero

The arm extension must never be allowed to become zero or negative as this will result in a jump in motion. You can set your **RS_LIMIT** to prevent this situation.

AXIS(2) - VERTICAL AXIS

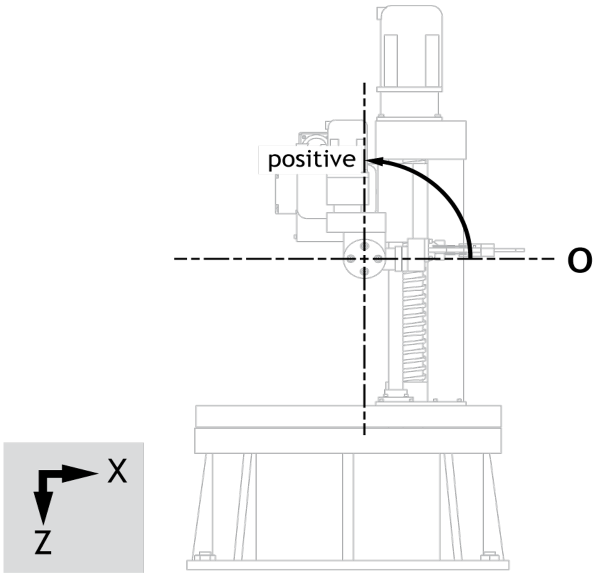


Home with zero at highest position

Positive direction is moving down

Range: 0 to infinite

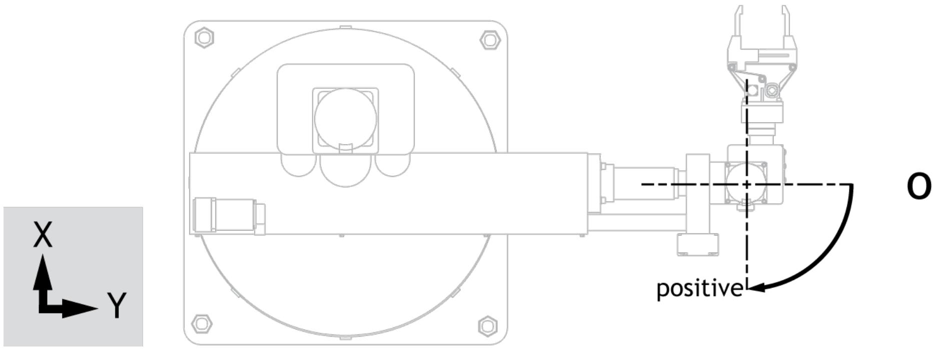
AXIS(3) – WRIST ROTATE ABOUT Y



Home so that the wrist is horizontal

Range: - infinite to infinite

AXIS(4) – WRIST ROTATE ABOUT Z



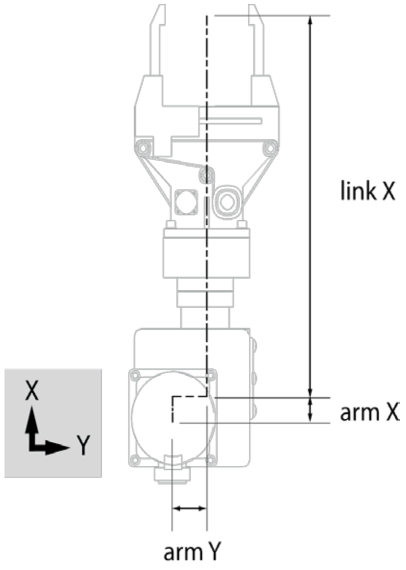
Home so that the zero position is along the y axis

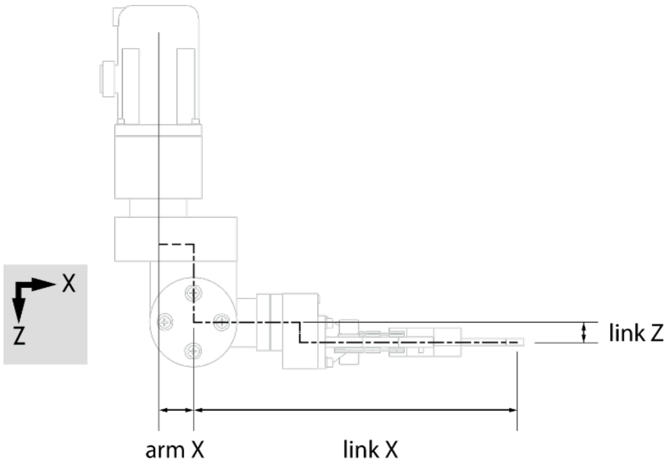
Positive direction is clockwise looking from above

Range: - infinite to infinite

PARAMETERS:

Table data	0	Edges per radian (base rotation)
	1	Edges per mm (arm extension)
	2	Edges per mm (vertical axis)
	3	Revolutions – set to 0
	4	Previous position – set to 0
	5	Linkx (optional with 4 or 5 axis)
	6	Linky (optional with 4 or 5 axis)
	7	Linkz (optional with 4 or 5 axis)
	8	Encoder edges/radian (optional Z rotation)
	9	Encoder edges/radian (optional Y rotation)





EXAMPLES:

EXAMPLE 1:

This example sets up a 5 axis system

```
      linkx = 50’mm
      linky = 50’mm
      linkz = 50’mm

      t1_encoder = 4*17000 ‘Encoder counts per revolution
      t1_gearbox = 50
      t1_edges_per_radian = t1_encoder * t1_gearbox / (2 * PI)
      t1_edges_per_degree = t1_encoder * t1_gearbox / (360)

      t2_encoder = 4*250 ‘Encoder counts per revolution
      t2_gearbox = 1
      t2_mm_per_rev = 1
      t2_edges_per_mm = t2_encoder * t2_gearbox / t2_mm_per_rev

      t3_encoder = 4*250 ‘Encoder counts per revolution
      t3_gearbox = 1
      t3_mm_per_rev = 1
      t3_edges_per_mm = t3_encoder * t3_gearbox / t3_mm_per_rev

      t4_encoder = 4*16000 ‘Encoder counts per revolution
      t4_gearbox = 50
      t4_edges_per_radian = t4_encoder * t4_gearbox / (2 * PI)
      t4_edges_per_degree = t4_encoder * t4_gearbox / (360)

      t5_encoder = 4*16000 ‘Encoder counts per revolution
      t5_gearbox = 50
      t5_edges_per_radian = t4_encoder * t4_gearbox / (2 * PI)
      t5_edges_per_degree = t4_encoder * t4_gearbox / (360)

      revolutions = 0
      prev_pos = 0

      group_size = 5

      TABLE(0, t1_edges_per_radian, t2_edges_per_mm, t3_edges_per_mm,
    revolutions, prev_pos)
      TABLE(5, linkx, linky, linkz, t4_edges_per_radian, t5_edges_per_
    radian)
    FRAME_GROUP(0,0,0,1,2,3,4)
    BASE(0)
      UNITS =FRAME_SCALE ‘mm
      BASE(1)
      UNITS =FRAME_SCALE ‘mm
      BASE(2)
      UNITS =FRAME_SCALE ‘mm
```

```
BASE(3)
UNITS =(FRAME_SCALE * 2 * PI) / (360)’degrees
BASE(4)
UNITS =(FRAME_SCALE * 2 * PI) / (360)’degrees

BASE(0,1,2)
MOVE(-100,-100,100)
MOVE(200,0)
MOVE(-100,100,-100)
BASE(0,1,zrot)
MHELICAL(0,0,0,-50,0,360,1)
MOVE(0,25,0)
MOVECIRC(0,0,0,-75,0)
```

EXAMPLE 1:

This example sets up a 4 axis system

```
  linkx = 50’mm
  linky = 50’mm
  linkz = 50’mm

  t1_encoder = 4*17000 ‘Encoder counts per revolution
  t1_gearbox = 50
  t1_edges_per_radian = t1_encoder * t1_gearbox / (2 * PI)
  t1_edges_per_degree = t1_encoder * t1_gearbox / (360)

  t2_encoder = 4*250 ‘Encoder counts per revolution
  t2_gearbox = 1
  t2_mm_per_rev = 1
  t2_edges_per_mm = t2_encoder * t2_gearbox / t2_mm_per_rev

  t3_encoder = 4*250 ‘Encoder counts per revolution
  t3_gearbox = 1
  t3_mm_per_rev = 1
  t3_edges_per_mm = t3_encoder * t3_gearbox / t3_mm_per_rev

  t4_encoder = 4*16000 ‘Encoder counts per revolution
  t4_gearbox = 50
  t4_edges_per_radian = t4_encoder * t4_gearbox / (2 * PI)
  t4_edges_per_degree = t4_encoder * t4_gearbox / (360)

  revolutions = 0
  prev_pos = 0

  group_size = 4

  TABLE(0, t1_edges_per_radian, t2_edges_per_mm, t3_edges_per_mm,
revolutions, prev_pos)
  TABLE(5, linkx, linky, linkz, t4_edges_per_radian)
```

```
FRAME_GROUP(0,0,0,1,2,3)
BASE(0)
  UNITS =FRAME_SCALE 'mm
  BASE(1)
  UNITS =FRAME_SCALE 'mm
  BASE(2)
  UNITS =FRAME_SCALE 'mm
  BASE(3)
  UNITS =(FRAME_SCALE * 2 * PI) / (360)'degrees
```

FRAME_GROUP

TYPE:
System Command

SYNTAX:
FRAME_GROUP(group, [table_offset, [axis0, axis1 ...axisn]])

DESCRIPTION:
FRAME_GROUP is used to define the group of axes and the table offset which are used in a **FRAME** or **USER_FRAME** transformation. There are 8 groups available meaning that you can run a maximum of 8 FRAMEs on the controller.

FRAME_GROUP requires the kinematic runtime **FEC**

Although 8 **FRAME**s can be initialised on a controller it may not be possible to process all 8 at a given **SERVO_PERIOD**. The number that can be run depends on many factors including, which **FRAME** is selected, drive connection method, if **USER_FRAME** and **TOOL_OFFSET** are enabled and additional factory communications.

The number of axes in the group must match the number of axes used by the **FRAME**. The axes must also be ascending order though they do not have to be contiguous. If a group is deleted **FRAME** and **USER_FRAME** are set to 0 for those axes.

To maintain backward compatibility if the **FRAME** command is used on an axis that is not in a group, or no groups are configured then a default group is created using the lowest axes and table_offset=0. In this situation if **FRAME_GROUP**(0) is already configured it is overwritten.

When the group is deleted **FRAME** is set to 0, **USER_FRAME**(0) is activated, **TOOL_OFFSET**(0) is activated and **VOLUME_LIMIT**(0) is activated. This means you can delete the **FRAME_GROUP** to reset all of these commands.

PARAMETERS:

group:	The group number, 0-7. When used as the only parameter **FRAME_GROUP** prints the **FRAME_GROUP**, the active **USER_FRAME** and **TOOL_OFFSET** information to the currently selected output channel (default channel 0)
table_offset:	-1 = Delete group data
	0+ = The start position in the table to store the **FRAME** configuration.
axis0:	The first axis in the group
axis1:	The second axis in the group
axisn:	The last axis in the group

The text returned when only printing **FRAME_GROUP** is in the following format:

group [table_offset] : axes {**USER_FRAME**: **USER_FRAME** parameters} TO={**TOOL_OFFSET** : **TOOL_OFFSET** parameters} VL={**VOLUME_LIMIT** parameters}

EXAMPLES:

EXAMPLE 1:

Configure a **FRAME_GROUP** for axes 1,2 and 5 using table offset 100.

```
    'Initialise the FRAME_GROUP
    FRAME_GROUP(0,100, 1,2,5)

    'Configure the axes, FRAME table data and home the robot
    GOSUB configure_frame

    'PRINT the FRAME_GROUP information to the command line
    FRAME_GROUP(0)

    'Enable the frame
    FRAME AXIS(1)=14
```

EXAMPLE 2:

Reset the **FRAME_GROUP** to set: **USER_FRAME**(0), **TOOL_OFFSET**(0), **FRAME** = 0 and **VOLUME_LIMIT**(0)

```
    BASE(0) 'Select an axis in the FRAME_GROUP
    FRAME_GROUP(0,-1)
```

EXAMPLE 3:

Print the **FRAME_GROUP** in the terminal.

```
    >>FRAME_GROUP(0,1,2,3,4,5)
    >>PRINT FRAME_GROUP(0)
    0 [1] : 2, 3, 4, 5 {0:0.00000, 0.00000, 0.00000, 0.00000, 0.00000,
    0.00000} TO={0
    :0.00000, 0.00000, 0.00000} VL={0, 0}
    0
```

FRAME_REP_DIST

TYPE:

Axis Parameter

DESCRIPTION:

Orientation axes on a **FRAME** or **USER_FRAME** must be programmed between ± half a revolution (**UNITS** can be used to set radians, degrees etc). This cannot be done using **REP_DIST** and has to be done using **FRAME_REP_DIST** and **REP_OPTION** bit 3.

When this is configured the **DPOS** will wrap to ± half a revolution and **AXIS_DPOS** will not be wrapped so that the absolute axis position is maintained.

Wrapping will only occur when **FRAME** <> 0 or **USER_FRAME** <> 0. While both are set to zero the wrapping will be inhibited so that the absolute axis position is maintained.

With **REP_OPTION** bit 3 set and **DPOS** exceeding **FRAME_REP_DIST** it will wrap to -**FRAME_REP_DIST**. The same applies in reverse so when **DPOS** exceeds -**FRAME_REP_DIST** it will wrap to **FRAME_REP_DIST**.

VALUE:

The position in user **UNITS** where the axis position wraps.

FRAME_REP_DIST uses *UNITS*. You must remember to set **FRAME_REP_DIST** while the correct *UNITS* are active.

EXAMPLES:

A 4 axis delta robot has one orientation axis which is the angle of rotation about the Z axis. The user is programming in degrees so the **DPOS** must be limited to ±180 degrees.

```
        BASE(axis_w)
        UNITS = (FRAME_SCALE*2*PI) / 360 'degrees
        FRAME_REP_DIST = 180
        REP_OPTION = 8
```

SEE ALSO:

REP_OPTION

FRAME_ SCALE

TYPE:
Axis Parameter

DESCRIPTION:
FRAME_ SCALE is used to adjust the resolution of the high accuracy FRAMEs (100+). The default value is very large and so the accuracy is sufficient for most applications.

VALUE:
Default value 1000000000

FRAME_TRANS

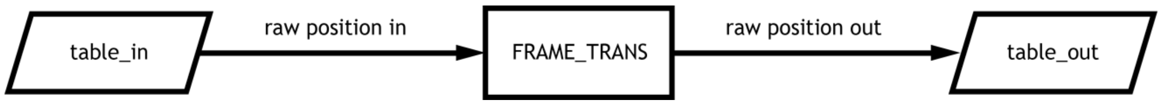
TYPE:
Mathematical Function

SYNTAX:
FRAME_TRANS(frame, table_in, table_out, direction [,table_offset])

DESCRIPTION:
This function enables you to perform both the forward and inverse transformation calculations of a **FRAME**. One particular use is to check following errors in user units or to calculate positions outside of the **FRAME** working area.

FRAME_TRANS requires the kinematic runtime **FEC** to use a **FRAME** 14 and higher.

The **FRAME** calculations are performed on raw position data. When using a **FRAME** typically the raw position data for **DPOS** is micrometres and the raw position data for **MPOS** is encoder counts but this can vary depending on which **FRAME** you select.



PARAMETERS:

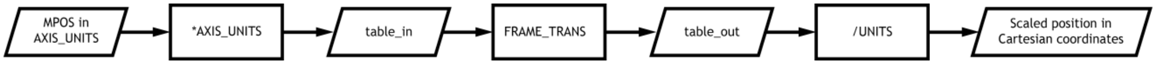
frame:	The **FRAME** number to run

table_in	The start position in the **TABLE** of the input positions
table_out	The start position in the **TABLE** of the generated positions
direction	1 = **AXIS_DPOS** to **DPOS** (Forward Kinematics)
	0 = **DPOS** to **AXIS_DPOS** (Inverse Kinematics)
table_offset	The first position in the table where the frame configuration is found (default 0)

EXAMPLES:

EXAMPLE 1:

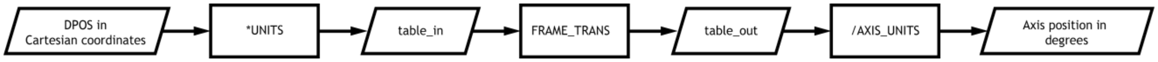
Using **MPOS** calculate the Cartesian values so you can compare them to **DPOS**. This can be used to check the following error in the world coordinate system. The frame configuration is stored in the table starting at position 100.



```
'Load positions into the table
FOR x=0 TO 3
BASE(x)
TABLE(1000+x,MPOS AXIS(x)*UNITS AXIS(x))
NEXT x
'Calculate forward transform to see MPOS is Cartesian coordinates
FRAME_TRANS(15, 1000,2000,1,100)

TABLE(3000, TABLE(2000)/ UNITS AXIS(0))
TABLE(3001, TABLE(2001)/ UNITS AXIS(1))
TABLE(3002, TABLE(2002)/ UNITS AXIS(2))
PRINT «DPOS IN ENCODER COUNTS»,TABLE(2000),TABLE(2001),TABLE(2002)
PRINT «DPOS IN MM»,TABLE(3000),TABLE(3001),TABLE(3002)
PRINT «FE in world x = «, TABLE(3000) - DPOS AXIS(0)
PRINT «FE in world y = «, TABLE(3001) - DPOS AXIS(1)
PRINT «FE in world z = «, TABLE(3002) - DPOS AXIS(2)
```

EXAMPLE 2:

Use the inverse kinematics to confirm that a demand position will result in an axis position that the motors can achieve.



```
'Load positions into the table
TABLE(5000,100*UNITS AXIS(0),200*UNITS AXIS(1),400*UNITS AXIS(2))
```

```
'Calculate reverse transform to see
FRAME_TRANS(14, 5000,6000,0)

'Divide the result by the AXIS_UNITS to get
'the MPOS in degrees
TABLE(7000, TABLE(6000)/ AXIS_UNITS)
TABLE(7001, TABLE(6001)/ AXIS_UNITS)
TABLE(7002, TABLE(6002)/ AXIS_UNITS)

PRINT "MPOS RAW ENCODER COUNTS", TABLE(6000),TABLE(6001),TABLE(6002)
PRINT "MPOS degrees", TABLE(7000),TABLE(7001),TABLE(7002)
```

FREE

TYPE:
System Parameter (Read Only)

DESCRIPTION:
Returns the amount of program memory available for user programs.

Each line takes a minimum of 4 characters (bytes) in memory. This is for the length of this line, the length of the previous line, number of spaces at the beginning of the line and a single command token. Additional commands need one byte per token, most other data is held as **ASCII**.

The *Motion Coordinator* compiles programs before they are run, this means that a little under twice the memory is required to be able to run a program.

VALUE:
The amount of available user memory in bytes.

EXAMPLE:
Check the available memory on the command line

```
>>PRINT FREE
47104.0000
>>
```

SEE ALSO:
DIR

FS_LIMIT

TYPE:
Axis Parameter

ALTERNATE FORMAT:
FSLIMIT

DESCRIPTION:
An end of travel limit may be set up in software thus allowing the program control of the working envelope of the machine. This parameter holds the absolute position of the forward travel limit in user units.

Bit 9 of the **AXISSTATUS** register is set when the axis position is greater than the **FS_LIMIT**.

When **DPOS** reaches **FS_LIMIT** the controller will cancel the move, so the axis will decelerate at **DECEL** or **FASTDEC**.

FS_LIMIT is disabled when it has a value greater than **REP_DIST**.

VALUE:
The absolute position of the software forward travel limit in user **UNITS**. (default = 200000000000)

EXAMPLES:

EXAMPLE 1:
Datum axis 1, then define a forward limit from this point.

```
BASE(1)
DATUM(3)
WAIT IDLE
FS_LIMIT=200
```

EXAMPLE 2:
Disable the **FS_LIMIT** by setting it greater than **REP_DIST**.

```
FS_LIMIT = REPDIST+10
```

SEE ALSO:
RS_LIMIT, FWD_IN, REV_IN

FULL_SP_RADIUS

TYPE:
Axis Parameter

DESCRIPTION:
This parameter is used with **CORNER_MODE**, it defines the minimum radius that will be executed at full speed. When a radius is smaller than **FULL_SP_RADIUS** the speed will be proportionally reduces so that:

VP_SPEED = **FORCE_SPEED** * radius/**FULL_SP_RADIUS**

Where radius is the radius of the corner that is executing.

VALUE:
The full speed radius in user **UNITS** (default = 0).

EXAMPLE:
In the following program, when the first **MOVECIRCSP** is reached the speed remains at 10 because the radius (8) is greater than that set in **FULL_SP_RADIUS**. For the second **MOVECIRCSP** the speed is reduced by 50% to a value of 5, because the radius is 50% of that stored in **FULL_SP_RADIUS**.

```
CORNER_MODE=8
MERGE=ON
SPEED=10
FULL_SP_RADIUS=6
DEFPOS(0,0)

MOVESP(10,10)
MOVESP(10,5)
MOVESP(5,5)
MOVECIRCSP(8,8,0,8,1)
MOVECIRCSP(3,3,0,3,1)
MOVESP(5,5)
MOVESP(10,5)
```

SEE ALSO:
CORNER_MODE

FWD_IN

TYPE:
Axis Parameter

DESCRIPTION:

This parameter holds the input number to be used as a forward limit input.

When the forward limit input is active any motion on that axis is **CANCELed.**

When **FWD_IN** is active **AXISSTATUS** bit 4 is set.

The input used for **FWD_IN** is active low.

When the forward limit input is active the controller will cancel the move, so the axis will decelerate at **DECEL** or **FASTDEC**.

VALUE:

-1	Disable the input as **FWD_IN** (default)
0-63	Input to use as forward input switch

Any type of input can be used, built in, Trio CAN I/O, CANopen or virtual.

EXAMPLE:

Initialise input 19 for the forward limit switch

```
    FWD_IN AXIS(9)=19
```

SEE ALSO:

REV_IN, FS_LIMIT, RS_LIMIT

FWD_JOG

TYPE:

Axis Parameter

DESCRIPTION:

This parameter holds the input number to be used as a jog forward input.

When the **FWD_JOG** input is active the axis moves forward at **JOGSPEED**.

The input used for *FWD_IN* is active low.

It is advisable to use *INVERT_IN* on the input for **FWD_JOG** so that 0V at the input disables the jog.

FWD_JOG overrides **REV_JOG** if both are active

VALUE:

-1	Disable the input as **FWD_JOG** (default)
0-63	Input to use as datum input

EXAMPLE:

Initialise the **FWD_JOG** so that it is active high on input 7

```
INVERT_IN(7,ON)
FWD_JOG=7
```

GET

TYPE:
System Command

SYNTAX:
`GET [#channel,] variable`

DESCRIPTION:
Waits for the arrival of a single character on the serial. The **`ASCII`** value of the character is assigned to the variable specified. The user program will wait until a character is available.

Poll **`KEY`** to check to if a character has been received before performing a **`GET`**.

PARAMETERS:

#channel:	See # for the full channel list (default 0 if omitted)
variable:	The variable to store the received character, this may be local variable, **VR** or **TABLE**

Performing a **`GET`** or **`GET`**#0 will suspend the command line until a character is sent on that channel.

EXAMPLES:

EXAMPLE 1:
Ask a user to enter ‘y’ for yes or ‘n’ for no on channel 5

```
start:
  PRINT#5, “Press ‘y’ for YES or ‘n’ for NO.”
  GET#5, char
  IF char = 121 THEN
    PRINT#5, “YES selected”
  ELSEIF char = 110 THEN
    PRINT#5, “NO selected”
  ELSE
    PRINT#5, “BAD selection”
    GOTO start
  ENDIF
```

EXAMPLE 2:
Clear the serial buffer then request the user to enter a name

```
WHILE KEY#2
```

```
      GET#2, dump
    WEND

    PRINT#2, "ENTER NAME"
    WAIT UNTIL KEY#2
    count=0
    WHILE char<> $D 'carrage return
      GET#2, char
      VR(count)=char
      count=count+1
    WEND
```

SEE ALSO:

LINPUT, PRINT, KEY

GLOBAL

TYPE:

System Command

SYNTAX:

GLOBAL "name", vr_number

DESCRIPTION:

Up to 1024 GLOBALs can be declared in the controller, these are available to all programs. **GLOBAL** declares the name as a reference to one of the global **VR** variables. The name can then be used both within the program containing the **GLOBAL** definition and all other programs in the *Motion Coordinator* project.

They should be declared on startup and for fast startup the program declaring **GLOBAL**s should also be the **ONLY** process running at power-up.

Once a **GLOBAL** has been assigned it cannot be changed, even if you change the program that assigns it.

While developing you may wish to clear or change a **GLOBAL**. You can clear a single **GLOBAL** by using the first parameter alone. All GLOBALs can be cleared by issuing **GLOBAL**. You can view all **GLOBALS** using **LIST_GLOBAL**.

PARAMETERS:

name:	Any user-defined name containing lower case alpha, numerical or underscore (_) characters.

vr_number:	The number of the **VR** to be associated with name.

EXAMPLE:

Initialise two GLOBALs and use then to adjust machine parameters.

```
    GLOBAL “screw_pitch”,12
    GLOBAL “ratio1”,534

    ratio1 = 3.56
    screw_pitch = 23.0
    PRINT screw_pitch, ratio1
```

SEE ALSO:

CONSTANT, LIST_GLOBAL

GOSUB..RETURN

TYPE:

Program Structure

SYNTAX:

```
GOSUB label
…
label:
  commands
RETURN
```

DESCRIPTION:

Stores the position of the line after the **GOSUB** command and then branches to the label specified. Upon reaching the **RETURN** statement, control is returned to the stored line.

GOSUB..RETRUN loops can be nested up to 8 deep in each program.

PARAMETERS:

commands:	TrioBASIC statements that you wish to execute
label:	A valid label that occurs in the program.

If the label does not exist an error message will be displayed at run time and the program execution halted.

You must not execute a **RETURN** without a **GOSUB** as a runtime error will be displayed and your program will stop.

EXAMPLES:

EXAMPLE 1:

```
      WHILE machine_active
        GOSUB routine1
        GOSUB routine2
      WEND
      STOP ‘prevents running into subroutines when machine stopped.

    routine1:
      PRINT “Measured Position=”;MPOS;CHR(13);
      RETURN

    routine2:
      PRINT “Demand Position=”;DPOS;CHR(13);
      RETURN
```

EXAMPLE 2:

Calculating values in a subroutine.

```
    y=1
    z=4
    GOSUB calc
    PRINT “New value = “, x
    STOP

    calc:
      x=y+z/2
    RETURN
```

SEE ALSO:

GOTO

GOTO

TYPE:

Program Structure

SYNTAX:

`GOTO label`

```
…
label:
```

DESCRIPTION:
Identifies the next line of the program to be executed.

PARAMETERS:

label:	A valid label that occurs in the program.

If the label does not exist an error message will be displayed at run time and the program execution halted.

EXAMPLE:
Use a **GOTO** to repeat a section of your program after a bad input

```
    start:
    PRINT#5, "Press 'y' for YES and 'n' for NO."
    GET#5,   char
    IF char = 121 THEN
      PRINT#5, "YES selected"
    ELSEIF char = 110 THEN
      PRINT#5, "NO selected"
    ELSE
      PRINT#5, "BAD selection"
      GOTO start
    ENDIF
```

SEE ALSO:
GOSUB

>   Greater Than

TYPE:
Comparison Operator

SYNTAX:
`<expression1> > <expression2>`

DESCRIPTION:
Returns **TRUE** if expression1 is greater than expression2, otherwise returns **FALSE**.

PARAMETERS:

Expression1:	Any valid TrioBASIC expression
Expression2:	Any valid TrioBASIC expression

EXAMPLES:

EXAMPLE 1:
The program will wait until the measured position is greater than 200

```
    WAIT UNTIL MPOS>200
```

EXAMPLE 2:
Set the value of **TRUE** into **VR** 0 as 1 is greater than 0

```
    VR(0)=1>0
```

>= Greater Than or Equal

TYPE:
Comparison Operator

SYNTAX
<expression1> >= <expression2>

DESCRIPTION:
Returns **TRUE** if expression1 is greater than or equal to expression2, otherwise returns **FALSE**.

PARAMETERS:

Expression1:	Any valid TrioBASIC expression
Expression2:	Any valid TrioBASIC expression

EXAMPLE:
If variable target holds a value greater than or equal to 120 then move to the absolute position of 0.

```
    IF target>=120 THEN MOVEABS(0)
```

HALT

TYPE:
System Command.

DESCRIPTION:
Halts execution of all running programs. You can use **HALT** in a program.

HALT does not stop any motion. Currently executing, or buffered moves will continue unless they are terminated with a **CANCEL** or **RAPIDSTOP** command.

EXAMPLE:
Use the command line to stop two running programs:

```
>>HALT%[Process 20:Line 2] (31) - Program is stopped
%[Process 21:Line 1] (31) - Program is stopped
>>
```

SEE ALSO:
CANCEL, RAPIDSTOP, STOP

# Hash

TYPE:
Special Character

SYNTAX:
command #channel

DESCRIPTION:
The # symbol is used to specify a communications channel to be used for serial input/output commands.

PARAMETERS:

Channel	Device
0	Ethernet port 0 (the command line)
1	RS232 port 1
2	RS485 port 2

Channel	Device
5	*Motion* Perfect user channel
6	*Motion* Perfect user channel
7	*Motion* Perfect user channel
8	Used for *Motion* Perfect internal operations
9	Used for *Motion* Perfect internal operations
40	Channel configured using the **OPEN** command
41	Channel configured using the **OPEN** command
42	Channel configured using the **OPEN** command
43	Channel configured using the **OPEN** command
44	Channel configured using the **OPEN** command
45-49	Reserved
50	1st Anybus module
51	2nd Anybus module
52	3rd Anybus module
53	4th Anybus module
54	5th Anybus module
55	6th Anybus module
56	7th Anybus module

Channels 5 to 9 are logical channels which are superimposed on to Port 0 by *Motion* Perfect.

EXAMPLES:

EXAMPLE 1:
Printing Ascii strings to different channels

```
    PRINT #1,"Printing data to RS232 Channel"
    PRINT #5,"Printing data to Motion Perfect Terminal 5"
```

EXAMPLE 2:
Checking for and receiving characters on Channel 6

```
    WHILE KEY #6
      GET #63, VR(123)
    WEND
```

SEE ALSO:
GET, KEY, LINPUT, OPEN, PRINT

HEX

TYPE:
String Function

SYNTAX:
value = HEX(number)

DESCRIPTION:
HEX returns the hexadecimal value for the decimal number supplied as a **STRING** which can be assigned to a **STRING** variable or be PRINTed.

PARAMETERS:

number:	A decimal value
value:	A hexadecimal **STRING** of the number

EXAMPLES:

EXAMPLE 1:
Print **AXISSTATUS** as a hexadecimal value on the command line

```
>>PRINT HEX(AXISSTATUS)
10
>>
```

EXAMPLE 2:
Append a hexadecimal number to a **STRING** variable

```
DIM value AS STRING
value = value + HEX(number)
```

SEE ALSO:
PRINT, STRING

HLM_COMMAND

TYPE:
Remote Command

SYNTAX:
`HLM_COMMAND(command, port[, node[, mc_area/mode[, mc_offset ]]])`

DESCRIPTION:
The **HLM_COMMAND** command performs a specific Host Link command operation to one or to all Host Link Slaves on the selected port. Program execution will be paused until the response string has been received or the timeout time has elapsed. The timeout time is specified by using the **HLM_TIMEOUT** parameter. The status of the transfer can be monitored with the **HLM_STATUS** parameter.

PARAMETERS:

command:	The the Host Link operation to perform:		
	HLM_MREAD	0	This performs the Host Link PC **MODEL READ** (MM) command to read the CPU Unit model code. The result is written to the MC Unit variable specified by mc_area and mc_offset.
	HLM_TEST	1	This performs the Host Link **TEST** (TS) command to check correct communication by sending string “MCxxx **TEST STRING**” and checking the echoed string. Check the **HLM_STATUS** parameter for the result.
	HLM_ABORT	2	This performs the Host Link **ABORT** (XZ) command to abort the Host Link command that is currently being processed. The **ABORT** command does not receive a response.
	HLM_INIT	3	This performs the Host Link **INITIALIZE** (**) command to initialize the transmission control procedure of all Slave Units.
	HLM_STWR	4	This performs the Host Link **STATUS WRITE** (SC) command to change the operating mode of the CPU Unit.
port:	The specified serial port. (See specific controller specification for numbers)		
node:	(for **HLM_MREAD**, **HLM_TEST**, **HLM_ABORT** and **HLM_STWR**):		
	The Slave node number to send the Host Link command to. Range: [0, 31].		

mode:	(for **HLM_STWR**)		
	The specified CPU Unit operating mode.		
	0	**PROGRAM** mode	
	2	**MONITOR** mode	
	3	RUN mode	
mc_area:	(for **HLM_MREAD**)		
	The MC Unit's memory selection to write the received data to.		
	MC_TABLE	8	Table variable array
	MC_VR	9	Global (VR) variable array
mc_offset:	(for **HLM_MREAD**)		
	The address of the specified MC Unit memory area to read from.		

When using **HLM_COMMAND**, be sure to set-up the Host Link Master protocol by using the **SETCOM** command.

The Host Link Master commands are required to be executed from one program task only to avoid any multi-task timing problems.

EXAMPLES:

EXAMPLE 1:

The following command will read the CPU Unit model code of the Host Link Slave with node address 12 connected to the RS-232C port. The result is written to **VR**(233).

```
HLM_COMMAND(HLM_MREAD,1,12,MC_VR,233)
```

If the connected Slave is a C200HX PC, then **VR**(233) will contain value 12 (hex) after successfull execution.

EXAMPLE 2:

The following command will check the Host Link communication with the Host Link Slave (node 23) connected to the RS-422A port.

```
HLM_COMMAND(HLM_TEST,2,23)
PRINT HLM_STATUS PORT(2)
```

If the **HLM_STATUS** parameter contains value zero, the communication is functional.

EXAMPLE 3:

The following two commands will perform the Host Link **INITIALIZE** and **ABORT** operations on the RS-422A port 2. The Slave has node number 4.

```
HLM_COMMAND(HLM_INIT,2)
HLM_COMMAND(HLM_ABORT,2,4)
```

EXAMPLE 4:

When data has to be written to a PC using Host Link, the CPU Unit can not be in RUN mode. The **HLM_COMMAND** command can be used to set it to **MONITOR** mode. The slave has node address 0 and is connected to the RS-232C port.

```
    HLM_COMMAND(HLM_STWR,2,0,2)
```

HLM_READ

TYPE:

Remote Command

SYNTAX:

`HLM_READ(port,node,pc_area,pc_offset,length,mc_area,mc_offset)`

DESCRIPTION:

The **HLM_READ** command reads data from a Host Link Slave by sending a Host Link command string containing the specified node of the Slave to the serial port. The received response data will be written to either **VR** or Table variables. Each word of data will be transferred to one variable. The maximum data length is 30 words (single frame transfer). Program execution will be paused until the response string has been received or the timeout time has elapsed. The timeout time is specified by using the **HLM_TIMEOUT** parameter. The status of the transfer can be monitored with the **HLM_STATUS** parameter.

PARAMETERS:

port:	The specified serial port. (See specific controller specification for numbers)			
node:	The Slave node number to send the Host Link command to. Range: [0, 31].			
pc_area:	The PC memory selection for the Host Link command.			
	pc_area		data area	Hostlink command
	PLC_DM	0	DM	RD
	PLC_IR	1	CIO/IR	RR
	PLC_LR	2	LR	RL
	PLC_HR	3	HR	RH
	PLC_AR	4	AR	RJ
	PLC_EM	6	EM	RE
pc_offset:	The address of the specified PC memory area to read from. Range: [0, 9999].			

length:	The number of words of data to be transfered. Range: [1, 30].		
mc_area:	The MC Unit's memory selection to write the received data to.		
	MC_TABLE	8	Table variable array
	MC_VR	9	Global (VR) variable array
mc_offset:	The address of the specified MC Unit memory area to write to.		

When using the **HLM_READ**, be sure to set-up the Host Link Master protocol by using the **SETCOM** command.

The Host Link Master commands are required to be executed from one program task only to avoid any multi-task timing problems.

HLM_STATUS

TYPE:
Port Parameter

DESCRIPTION:
Returns the status of the Host Link serial communications.

HLM_TIMEOUT

TYPE:
System Parameter

DESCRIPTION:
Sets the timeout value for Hostlink communications.

VALUE:
Timeout in msec, default 500msec

EXAMPLE:
Set the Hostlink timeout to 600msec.

```
    HLM_TIMEOUT = 600
```

HLM_WRITE

TYPE:

Remote Command

SYNTAX:

`HLM_WRITE(port,node,pc_area,pc_offset,length,mc_area,mc_offset)`

DESCRIPTION:

The **`HLM_WRITE`** command writes data from the MC Unit to a Host Link Slave by sending a Host Link command string containing the specified node of the Slave to the serial port. The received response data will be written from either **`VR`** or Table variables. Each variable will define on word of data which will be transferred. The maximum data length is 29 words (single frame transfer). Program execution will be paused until the response string has been received or the timeout time has elapsed. The timeout time is specified by using the **`HLM_TIMEOUT`** parameter. The status of the transfer can be monitored with the **`HLM_STATUS`** parameter.

PARAMETERS:

port:	The specified serial port. (See specific controller specification for numbers)			
node:	The Slave node number to send the Host Link command to. Range: [0, 31].			
pc_area:	The PC memory selection for the Host Link command.			
	pc_area		data area	Hostlink command
	PLC_DM	0	DM	RD
	PLC_IR	1	CIO/IR	RR
	PLC_LR	2	LR	RL
	PLC_HR	3	HR	RH
	PLC_AR	4	AR	RJ
	PLC_EM	6	EM	RE
	PLC_REFRESH	7		
pc_offset:	The address of the specified PC memory area to write to. Range: [0, 9999].			
length:	The number of words of data to be transfered. Range: [1, 30].			

mc_area:	The MC Unit's memory selection to read the data from.		
	`MC_TABLE`	8	Table variable array
	`MC_VR`	9	Global (VR) variable array
mc_offset:	The address of the specified MC Unit memory area to read from.		

When using the **HLM_WRITE**, be sure to set-up the Host Link Master protocol by using the **SETCOM** command.

The Host Link Master commands are required to be executed from one program task only to avoid any multi-task timing problems.

EXAMPLE:

The following example shows how to write 25 words from MC Unit's **VR** addresses 200-224 to the PC EM area addresses 50-74. The PC has Slave node address 28 and is connected to the RS-232C port.

```
    HLM_WRITE(1, 28, PLC_EM, 50, 25, MC_VR, 200)
```

HLS_MODEL

TYPE:

System Parameter

DESCRIPTION:

Defines the model number returned to a Hostlink Master.

VALUE:

The model number returned. Default 250

HLS_NODE

TYPE:

System Parameter

DESCRIPTION:

Sets the Hostlink node number for the slave node. Used in multidrop RS485 Hostlink networks or set to 0 for RS232 single master/slave link.

HMI_CONNECTIONS

TYPE:
System Parameter

SYNTAX:
`HMI_CONNECTIONS`

DESCRIPTION:
Return the connection strings for all currently connected clients.

VALUE:

value	A string that contains the connection strings for all the connected clients. Each connection string is on a separate line. Each line has the following structure: <session>;<major>;<minor>;<ip>;<platform>;<osversion>;<window> Where: <session> is the corresponding session id (0, 1, ...) <major> is the major version of the HMI Client <minor> is the minor version of the HMI Client <ip> is the IP address of the HMI Client <platform> is the definition of the hardware the HMI Client is running on. 1 => WindowsCE 2 => Windows Desktop <osversion> is the version reported by the platform. The major version number is stored in the most significant byte and the minor version number is stored in the least significant byte. <window> is the size of the HMI Client screen. The width is stored in the most significant byte and the height is stored in the least significant byte.

EXAMPLE:
Report the currently connected HMI Clients.

```
    >>PRINT HMI_CONNECTIONS
    0;1.22.4.502;127.0.0.1;2;60001;32001e0
    1;1.22.3.500;192.168.2.53;1;50000;32001e0
```

SEE ALSO:
`HMI_GET_PAGE, HMI_GET_STATUS, HMI_SERVER, HMI_SET_PAGE`

HMI_GET_PAGE

TYPE:
System Function

SYNTAX:
`value = HMI_GET_PAGE[(<ip>)]`

DESCRIPTION:
Return the currently selected page on the given HMI Client. If the IP address is not specified then the current page for the lowest active session will be returned.

PARAMETERS:

value	A string that contains the name of the current page on the HMI Client.
IP	IP address of the HMI Client to which this message must be sent.

EXAMPLE:
Automatically reset the current page on the HMI Client.

```
WHILE(1)
  IF VR(0)<>0 AND HMI_GET_PAGE<>"PAGE1" THEN
    HMI_SET_PAGE("PAGE1")
    VR(0)=0
  ENDIF
WEND
```

SEE ALSO:
HMI_CONNECTIONS, HMI_GET_STATUS, HMI_SERVER, HMI_SET_PAGE

HMI_GET_STATUS

TYPE:
System Function

SYNTAX:
`value = HMI_GET_STATUS[(<ip>)]`

DESCRIPTION:
Return the status of the given HMI Client. If the IP address is not specified then the current page for the

lowest active session will be returned.

PARAMETERS:

value	-1	HMI Client is not connected
	1	HMI Client is Connected
	2	HMI Page is loading
	3	HMI Page is running
	4	HMI Client is in error
IP	IP address of the HMI Client to which this message must be sent.	

EXAMPLE:

Wait for the HMI Client to initialise correctly, change to the start page and wait for the change to complete.

```
    WAIT UNTIL HMI_GET_STATUS=3
    HMI_SET_PAGE("START")
    WAIT UNTIL HMI_GET_STATUS=3 AND HMI_GET_PAGE="START"
```

SEE ALSO:

HMI_CONNECTIONS, **HMI_GET_PAGE**, **HMI_SERVER**, **HMI_SET_PAGE**

HMI_PROC

TYPE:

System Parameter (**MC_CONFIG**)

SYNTAX:

HMI_PROC=value

DESCRIPTION:

Sets the process number on which the HMI Server protocol will be initiated. This value must be set before the first HMI Client connection occurs. The default value at power up is -1, which will automatically select the process number according to the normal RUN command rules.

If this value is to be set, then it is recommended that it be set in the special **MC_CONFIG** program to insure that the value is valid before any HMI Client can connect to the *Motion Coordinator.*

HMI_SERVER

TYPE:

System Command

SYNTAX:

`HMI_SERVER[ (function [, parameters…])]`

DESCRIPTION:

This command allows the Trio HMI Server to be controlled, configured and interrogated from a TrioBASIC program.

If there are no parameters then the function is 0, and the parameter is 0.

PARAMETERS:

Function	0	Run the **HMI_SERVER** protocol
	1	Read the HMI Client error data
	2	Write the **HMI_SERVER** event flags
	3	Read the **HMI_SERVER** status data
	4	Set the HMI poll timeout
	5	Read the HMI Client version information

FUNCTION = 0:

SYNTAX:

`HMI_SERVER`

`HMI_SERVER(0[,debug])`

DESCRIPTION:

This function starts the **HMI_SERVER** protocol. This function never stops, so no TrioBASIC statement after this command in a program will be executed.

The **HMI_SERVER** program is normally started automatically when the **HMI** Client connects to the *Motion Coordinator*. You can call it manually if you wish to specify which process it should run on and whether it should print debug information.

If you execute **HMI_SERVER** manually the program it runs in will suspend at the **HMI_SERVER** line. The **HMI_SERVER** therefore should be the last line of the program to execute.

PARAMETERS:

Debug	0	No debug information
	1	Debug information printed to channel 0 (only use when requested by Trio)

FUNCTION = 1:

SYNTAX:

```
value = HMI_SERVER(1, error_parameter)
```

DESCRIPTION:

When an error occurs in the HMI Client, this event is sent to the HMI Server if possible. This command will return the data about the last error that occurred in the HMI Client.

PARAMETERS:

error_parameter	0	Error number	Specific to the HMI Client operating system
	1	Error string	Specific to the HMI Client operating system
	2	Error program	When applicable, the name of the program on the *Motion Coordinator* with which the HMI Client was communicating when the error occurred.
	3	Error process	When applicable, the process number of the program on the *Motion Coordinator* with which the HMI Client was communicating when the error occurred.

EXAMPLE:

Report an error on the HMI Client

```
    'Check for error
    IF HMI_SERVER(1,0) THEN
        PRINT "HMI Client reports error"
        PRINT "HMI Error=";HMI_SERVER(1,0)
        PRINT "HMI Description=";HMI_SERVER(1,1)
        PRINT "MC Program=";HMI_SERVER(1,2)
        PRINT "MC Process=";HMI_SERVER(1,3)
    ENDIF
```

FUNCTION = 2:

SYNTAX:

HMI_SERVER(2, parameter [, string [, client_ip]])

DESCRIPTION:

The HMI Server can inform the HMI Client that certain events have occurred. These events are used by MotionPerfectV3. The optional client_ip is currently ignored by the **HMI_SERVER** command. The string parameter depends on value of parameter.

PARAMETERS:

parameter	0	No event
	1	The *Motion Coordinator* has an updated HMI Design file, the HMI Client must request it. String is the name of the file on the *Motion Coordinator* to be read.
	2	Request that the HMI Client send its' current configuration file. String is the name on the *Motion Coordinator* of the file to be written.
	4	The *Motion Coordinator* has an updated HMI configuration file, the HMI Client must request it. String is the name of the file on the *Motion Coordinator* to be read.
	8	The *Motion Coordinator* has an updated HMI Client firmware file, the HMI Client must request it. String is the name of the file on the *Motion Coordinator* to be read.
	32	Set the current page on the HMI Client, the next parameters specifies the page name. String is the name of the page to be selected.

EXAMPLE:

Automatically scroll through three pages at a time interval of 5 seconds. If a page is manually selected then hold a page for 30 seconds. The page value is set from the HMI to a value greater than 3 to put the page on manual mode.

```
page = 0
page_time = 5000
manual_time = 30000

WHILE(1)
  IF page = 0 THEN
    HMI_SERVER(2,32,"PAGE1")
    page = 1
    WA(page_time)
  ELSEIF page = 1 THEN
    HMI_SERVER(2,32,"PAGE2")
    page = 2
    WA(page_time)
  ELSEIF page = 2 THEN
    HMI_SERVER(2,32,"PAGE3")
    page = 3
    WA(page_time)
  ELSE
    'in manual mode
    page = 0
    TICKS = manual_time
    WHILE TICKS>0
      IF page <> 0 THEN
        TICKS = manual_time
        page = 0
      ENDIF
      WA(1)
    WEND
  ENDIF
WEND
```

FUNCTION = 3:

SYNTAX:
`value = HMI_SERVER(3, parameter, return_type)`

DESCRIPTION:
Read the HMI Client status information.

PARAMETERS:

parameter	0	Client status:	
		0	Disconnected
		1	Connected
		2	HMI page loaded
		3	Running
		4	In error
	1	Current HMI Design page	
return_type	0	Integer	
	1	String	

FUNCTION = 4:

SYNTAX:

`HMI_SERVER(4, parameter)`

DESCRIPTION:

Set the number of milliseconds without activity that the HMI Server will wait before aborting a client connection.

FUNCTION = 5:

SYNTAX:

`value = HMI_SERVER(5, parameter)`

DESCRIPTION:

Return the HMI Client description. The HMI Client sends this data to the HMI Server during the protocol initialisation.

PARAMETERS:

parameter	0	HMI Client Engine major version number	
	1	HMI Client Engine minor version number	
	2	HMI Client Communications Protocol major version number	
	3	HMI Client Communications Protocol minor version number	
	4	HMI Client OS ID:	
		0	Windows CE
		1	Windows Desktop
	5	HMI Client OS Version:	
		Bit 0-15	Minor number
		Bit 16-31	Major number
	6	HMI Client Canvas Size:	
		Bit 0-15	Width in pixels
		Bit 16-31	Height in pixels

SEE ALSO:

`HMI_CONNECTIONS, HMI_GET_PAGE, HMI_GET_STATUS, HMI_SET_PAGE`

HMI_SET_PAGE

TYPE:

System Command

SYNTAX:

`HMI_SET_PAGE(<name>[,<ip>])`

DESCRIPTION:

Request that the HMI Client change to the given page. If the IP address is not specified the request will be sent to all currently connected clients. This command will wait for all pending HMI Client requests to complete before submitting the new request, but it will not wait for the HMI Client to complete the request. This means the controller will continue to run the software without waiting for the requested page to show on the HMI Client.

PARAMETERS:

name	Name of the page in the HMI Design on the HMI Client. This name is case sensitive.
IP	IP address of the HMI Client to which this message must be sent.

EXAMPLE:

Automatically scroll through three pages at a time interval of 5 seconds. If a page is manually selected then hold a page for 30 seconds. The page value is set from the HMI to a value greater than 3 to put the page on manual mode.

```
page = 0
page_time = 5000
manual_time = 30000

WHILE(1)
  IF page = 0 THEN
    HMI_SET_PAGE("PAGE1")
    page = 1
    WA(page_time)
  ELSEIF page = 1 THEN
    HMI_SET_PAGE("PAGE2")
    page = 2
    WA(page_time)
  ELSEIF page = 2 THEN
    HMI_SET_PAGE("PAGE3")
    page = 3
    WA(page_time)
  ELSE
    'in manual mode
```

```
        page = 0
        TICKS = manual_time
        WHILE TICKS>0
          IF page <> 0 THEN
            TICKS = manual_time
            page = 0
          ENDIF
          WA(1)
        WEND
      ENDIF
    WEND
```

SEE ALSO:

HMI_CONNECTIONS, HMI_GET_PAGE, HMI_GET_STATUS, HMI_SERVER

HW_PSWITCH

TYPE:

Axis command

SYNTAX:

HW_PSWITCH(mode, direction, opstate, table_start, table_end)

DESCRIPTION:

The **HW_PSWITCH** command is used to control an output based on a position. It can either can either turn on the output when the start position is reached, and turn the output off when the next position is reached.

The output is a 24V output linked to the axis.

HW_PSWITCH outputs are assigned to the axes in a fixed way with one output per axis. See note 1.

The positions are defined as a sequence in the **TABLE** memory in range from table_start to table_end. On execution of the **HW_PSWITCH** command the positions are stored in a **FIFO** (first in – first out) queue.

The MC464 FlexAxis has 256 positions in the **FIFO**

The MC403 and MC405 have 512 positions in the **FIFO**

This command is applicable only to Flexible axes with ATYPEs that use incremental encoders, stepper or quadrature outputs.

When using a step direction output or encoder output **ATYPE** the positions do not take into account the 16 times multiplier. This means that you should enter your positions as ‘position * 16’.

The command can be used with either 1 or 5 parameters. Only 1 parameter is needed to disable the switch or clear **FIFO** queue. All five parameters are needed to enable the switch.

After loading the **FIFO** and going through the sequence of positions in it, if the same sequence has to be executed again, the **FIFO** must be cleared before executing another **HW_PSWITCH** command with the same parameters.

PARAMETERS:

mode:	0	Disable switch
	1	Toggles Digital Output at specified positions which are loaded into the HW **FIFO**.
	2	Clear **FIFO**
direction:	0	**MPOS** decreasing
	1	**MPOS** increasing.
opstate:	Output state to set in the first position in the **FIFO**; ON or OFF.	
table_start:	Starting **TABLE** address of the sequence.	
table_end:	Ending **TABLE** address of the sequence.	

NOTES:

NOTE 1:

The MC464 requires either the P874 or P879 Flexible Axis Module. The module has 4 digital outputs which are connected to the first 4 axes in the Flexaxis 8. In the Flexaxis 4, the first 2 axes have **HW_PSWITCH** circuits using the first 2 module outputs.

The MC405 has 5 **HW_PSWITCH** outputs. Axis 0 uses Output 8 and each axis in sequence uses the next output up to axis 4, which uses Output 12.

The MC403 has 3 **HW_PSWITCH** outputs. Axis 0 uses Output 8 and each axis in sequence uses the next output up to axis 2, which uses Output 10.

EXAMPLES:

EXAMPLE 1:

Load the table with 30 ON/OFF positions then run the command to load the **FIFO** with these positions. When the position stored in **TABLE**(21) is reached, the PSn output will be set ON and then alternatively OFF and ON on reaching the following positions in the sequence, until the position stored in **TABLE**(50) is reached.

```
    TABLE(21,5,10,15,18,20,24,30,33,45,51,56,57,65,76,79,84,88,90,94)
    TABLE(40,99,105,120,140,145,190,235,260,271,280,300)
    HW_PSWITCH(1, 1, ON, 21, 50)
```

EXAMPLE 2:

Disable the switch if it was enabled previously. Does not clear the **FIFO** queue.

```
    HW_PSWITCH(0)
```

EXAMPLE 3:
Clear the **FIFO** queue of a switch not on the **BASE** axis.

```
    HW_PSWITCH(2) AXIS(8)
```

HW_TIMER

TYPE:
SLOT command

SYNTAX:
HW_TIMER(mode, cycleTime, <onTime, reps, > opState, opMode, opSel)

DESCRIPTION:
The **HW_TIMER** command turns ON/OFF a digital output or enable output of an axis for a specified length of ‘cycleTime’ (microseconds) in mode 1 or ‘onTime’ (microseconds) in mode 2 within the overall on/off time ‘cycleTime’.

The command can be used with either 1, 5 or 7 parameters. Only 1 parameter is needed to disable the timer. Five parameters are needed to enable the timer in mode 1, seven parameters for mode 2.

Note that the internal **FPGA** timer resolution is 10us so the requested time will be divided by 10 thus effectively truncating any remainder less than 10us e.g. 27 us will be interpreted as 20us. The user should also consider the rise/fall times of digital outputs, for highest performance then enable output selection should be used.

When using mode1 or 2 you must use an *ATYPE* with an enable output.

This command is only supported on controllers that have the correct *FPGA_PROGRAM*

PARAMETERS:

mode:	0	Disable timer
	1	Starts timer after which the selected output changes state.
	2	Starts timer after which the selected output changes state and then changes state again at the end of the overall cycle time and repeats for the given number of repetitions.
cycleTime:	Specifies in microseconds the timer cycle time to be used. For mode 1 this is effectively the ON time.	

onTime	Mode 2 only, specifies in microseconds the timer ON time to be used within the overall ‘cycleTime’.	
reps	Mode 2 only, specified how many repetitions of the ‘cycleTime’ sequence are required.	
opState:	Initial state of selected output, ON or OFF.	
opMode:	0	Indicates that a digital output is to be controlled.
	1	Indicates that a Enable output output is to be controlled.
	2	Indicates that a digital output and enable output output are to be controlled. These are only available in fixed pairs: axis 0 + Digital Output 8 axis 1 + Digital Output 9 axis 2 + Digital Output 10 axis 3 + Digital Output 11 axis 4 + Digital Output 12
opSel:	For opMode=0 this selects which digital output is to be controlled; valid range is 8..15. For opMode=1 this selects which axis enable output (0..4) is to be controlled; valid range is 0..4. For opMode=2 this selects which digital output and axis enable output is to be controlled; valid range is 0..4 which is interpreted as 8..12 for the corresponding digital output.	

EXAMPLES:

EXAMPLE 1:
Request output 14 to be ON for 350us.

```
    HW_TIMER(1,350,ON,0,14)
```

EXAMPLE 2:
Disable the timer after it was enabled previously.

```
    HW_TIMER(0)
```

EXAMPLE 3:
Request enable output of axis 2 to be ON for 1.5s.

```
    HW_TIMER(1,1500000,ON,1,2)
```

EXAMPLE 4:
Request digital output 9 and enable output of axis 1 to be OFF for 200ms.

```
    HW_TIMER(1,200000,OFF,2,1) : WAIT UNTIL HW_TIMER_DONE
```

EXAMPLE 5:
Request a cycle time of 1s to be repeated 10 times with digital output 13 being ON for 3500us within each

cycle.

```
    HW_TIMER(2,1000000,3500,10,ON,0,13)
```

SEE ALSO:
HW_TIMER_DONE

HW_TIMER_DONE

TYPE:
SLOT command (Read Only)

SYNTAX:
HW_TIMER_DONE

DESCRIPTION:
Indicates whether or not a requested **HW_TIMER** is complete.

VALUE:

TRUE	The previous **HW_TIMER** request is complete
FALSE	The previous **HW_TIMER** request is NOT complete

EXAMPLE:
Request enable output of axis 4 to be ON for 500ms.

```
    HW_TIMER(1,500000,ON,1,4) : WAIT UNTIL HW_TIMER_DONE
```

SEE ALSO:
HW_TIMER

I_GAIN

TYPE:
Axis Parameter

DESCRIPTION:
Used as part of the closed loop control, adding integral gain to a system reduces position error when at rest or moving steadily. It will produce or increase overshoot and may lead to oscillation.

For an integral gain Ki and a sum of position errors $\int_e$, the contribution to the output signal is:

$$O_i = K_i \times \int_e$$

VALUE:
The integral gain is a constant which is multiplied by the sum of following errors. Default value = 0

EXAMPLE:
Setting the gain values as part of a **STARTUP** program

```
P_GAIN=1
I_GAIN=0.01
D_GAIN=0
OV_GAIN=0
…
```

IDLE

TYPE:
Axis Parameter

DESCRIPTION:
Checks to see if an axis **MTYPE** is **IDLE**

VALUE:

TRUE	**MTYPE** is empty (**MTYPE**=0)
FALSE	**MTYPE** has a command loaded (**MTYPE**<>0)

EXAMPLES:

EXAMPLE 1:

Start a move and then suspend program execution until the move has finished. Note: This does not necessarily imply that the axis is stationary in a servo motor system.

```
MOVE(100)
WAIT IDLE
PRINT “Move Done”
```

EXAMPLE 2:

If the axis does not have any moves loaded then load a new sequence.

```
IF IDLE AXIS(1) THEN
  MOVE(100)
  MOVE(50)
  MOVE(-150)
ENDIF
```

IEEE_IN

TYPE:

Mathematical Function

SYNTAX:

`IEEE_IN(byte0,byte1,byte2,byte3)`

DESCRIPTION:

The **IEEE_IN** function returns the floating point number represented by 4 bytes which typically have been received over a communications link such as Modbus.

PARAMETERS:

byte0 - 3:	Any combination of 8 bit values that represents a valid **IEEE** floating point number.

Byte 0 is the high byte of the 32 bit floating point format.

EXAMPLE:

Take 4 bytes that have been sent over Modbus to **VR**s and recombine them into a floating point number.

```
VR(200) = IEEE_IN(VR(0),VR(1),VR(2),VR(3))
```

IEEE_OUT

TYPE:
Mathematical Function

SYNTAX:
```
byte_n = IEEE_OUT(value, n)
```

DESCRIPTION:
The **IEEE_OUT** function returns a single byte in **IEEE** format extracted from the floating point value for transmission over a communication bus system. The function will typically be called 4 times to extract each byte in turn.

PARAMETERS:

value:	Any TrioBASIC floating point variable or parameter.
n:	The byte number (0 - 3) to be extracted.

Byte 0 is the high byte of the 32 bit floating point format.

EXAMPLE:
Extract the 4 bytes from **MPOS** and store then in local variables ready for transmission over a communications bus.
```
    a = MPOS AXIS(2)
    byte0 = IEEE_OUT(a, 0)
    byte1 = IEEE_OUT(a, 1)
    byte2 = IEEE_OUT(a, 2)
    byte3 = IEEE_OUT(a, 3)
```

IF..THEN..ELSEIF..ELSE..ENDIF

TYPE:
Program Structure

SYNTAX:
```
IF condition THEN
  commands
ELSEIF expression THEN
  commands
```

```
ELSE
  commands
ENDIF
```

DESCRIPTION:
An IF program structure is used to execute a block of code after a valid expression. The structure will execute only one block of commands depending on the conditions. If multiple expressions are valid then the first will have its commands executed. If no expressions are valid and an **ELSE** is present the commands under the **ELSE** will be executed.

PARAMETERS:

condition:	Any valid logical TrioBASIC expression
commands:	TrioBASIC statements that you wish to execute

EXAMPLES:

EXAMPLE 1:
Check for the batch to be complete, if it is then tell the user and process the batch

```
    IF count >= batch_size THEN
      PRINT #3,CURSOR(20);"   BATCH COMPLETE   ";
      GOSUB index 'Index conveyor to clear batch
      count=0
    ENDIF
```

EXAMPLE 2:
Use an IF statement to light a warning lamp when machine is running

```
    IF WDOG=ON THEN
      OP(warning, ON)
    ELSE
      OP(warning, OFF)
    ENDIF
```

EXAMPLE 3:
Use an IF structure to report the operating state of a machine.

```
    IF operating_state=0 THEN
      PRINT#5, "Machine Running"
    ELSEIF operating_state=1 THEN
      PRINT#5, "Machine Idle"
    ELSEIF operating_state=2 THEN
      PRINT#5, "Machine Jammed"
    ELSE
      PRINT#5, "Machine in unknown state"
    ENDIF
```

IN

TYPE:
System Function.

SYNTAX:
```
value = IN[(input_no[,final_input])]
```

DESCRIPTION:
IN is used to read the state of the inputs.

If called with no parameters, IN returns the binary sum of the first 32 inputs. If called with one parameter it returns the state (1 or 0) of that particular input channel. If called with 2 parameters IN() returns in binary sum of the group of inputs.

In the 2 parameter case the inputs should be less than 32 apart.

IN is equivalent to **IN**(0,31)

PARAMETERS:

value:	The state of the selected input or range of inputs
none:	Returns the binary sum of the first 32 inputs
input_no:	input to return the value of/start of input group
final_input:	last input of group

EXAMPLES:

EXAMPLE 1:
In this example a single input is tested:
```
    WAIT UNTIL IN(4)=ON
    GOSUB place
```

EXAMPLE 2:
Move to the distance set on a thumb wheel multiplied by a factor. The thumb wheel is connected to inputs 4,5,6,7 and gives output in binary coded decimal.

The move command is constructed in the following order:

Step 1: IN(4,7) will get a number 0..15

Step 2: multiply by 1.5467 to get required distance

Step 3: absolute **MOVE** to this position

```
    WHILE TRUE
      MOVEABS(IN(4,7)*1.5467)
      WAIT IDLE
    WEND
```

EXAMPLE 3:
Test if either input 2 or 3 is ON.

```
    If (IN and 12) <> 0 THEN GOTO start
    '(Bit 2 = 4 + Bit 3 = 8) so mask = 12
```

INCLUDE

TYPE:
System Command.

SYNTAX:
`INCLUDE "filename"`

DESCRIPTION:
The `INCLUDE` command resolves all local variable definitions in the included file at compile time and allows all the local variables to be declared "globally".

Whenever an included program is modified, all programs that depend on it are re-compiled as well, avoiding inconsistencies.

Nested `INCLUDE`s are not allowed.

The `INCLUDE` command must be the first BASIC statement in the program.

Only variable definitions and conditional logic are allowed in the include file. It cannot be used as a general subroutine with any other BASIC commands in it.

PARAMETERS:

filename:	The name of the program to be included

EXAMPLE:
Initialise all local variables with an include program.

`PROGRAM` **"T1":**

```
    ‘include global definitions
    INCLUDE “GLOBAL_DEFS”
    ‘Motion commands using defined vars
    FORWARD AXIS(drive_axis)
    CONNECT(1, drive_axis) AXIS(link_axis)
```

PROGRAM “GLOBAL_DEFS”:

```
    drive_axis=4
    linked_axis=1
```

INDEVICE

TYPE:

Process Parameter

DESCRIPTION:

This parameter specifies the default active input device. Specifying an **INDEVICE** for a process allows the channel number for a program to set for all subsequent **GET**, **KEY**, **INPUT** and **LINPUT** statements.

This command is process specific so other processes will use the default channel.

This command is available for backward compatibility, it is currently recommended to use #channel, instead.

VALUE:

The channel number to use for any inputs

For a full list of communication channels see #

EXAMPLE:

Set up a program to use channel 5 by default for any **GET** commands

```
    INDEVICE=5
    ‘ Get character on channel 5:
    IF KEY THEN
      GET k
    ENDIF
```

SEE ALSO:

#, GET, INPUT, KEY, LINPUT

INITIALISE

TYPE:
System Command.

DESCRIPTION:
Sets all axis, system and process parameters to their default values.

The parameters are also reset each time the controller is powered up, or when an **EX** (software reset) command is performed.

INITIALISE may reset a parameter relating to a digital drive communication or encoder causing you to lose the connection.

EXAMPLE:
When developing you wish to clear all parameters back to default using the command line.

```
>>INITIALISE
>>
```

INPUT

TYPE:
System Command.

SYNTAX:
`INPUT [#channel,] variable [, variable…]`

DESCRIPTION:
Waits for an **ASCII** string to be received on the current input device, terminated with a carriage return <CR>. If the string is valid its numeric value is assigned to the specified variable. If an invalid string is entered it is ignored, an error message displayed and input repeated. Multiple values may be requested on one line, the values are separated by commas, or by carriage returns <CR>.

Poll **KEY** to check to if a character has been received before performing an **INPUT**.

PARAMETERS:

#channel:	See # for the full channel list (default 0 if omitted)
variable:	The variable to store the received character, this may be local variable, **VR** or **TABLE**

Performing an **INPUT** or **INPUT**#0 will suspend the command line until a character is sent on that channel.

EXAMPLES:

EXAMPLE 1:

Receive a single value and store it in a local variable num

```
INPUT num
PRINT "BATCH COUNT=";num[0]

On terminal:
123 <CR>
BATCH COUNT=123
```

EXAMPLE 2:

Get the length and width variables using one **INPUT**.

```
PRINT "ENTER LENGTH AND WIDTH?";
INPUT VR(11),VR(12)
```

This will display on terminal:

```
ENTER LENGTH AND WIDTH ? 1200,
1500 <CR>
```

SEE ALSO:

#, KEY

INPUTS0 / INPUTS1

TYPE:

System Parameter

DESCRIPTION:

The INPUTS0/ INPUTS1 parameters holds the state of the Input channels as a system parameter.

Reading the inputs using these system parameters is not normally required. The **IN**(x,y) command should be used instead. They are made available in this format to make the input channels accessible to the **SCOPE** command which can only store parameters.

VALUE:

INPUTS0	The binary sum of IN(0)..IN(15)
INPUTS1	The binary sum of IN(16)..IN(31)

SEE ALSO:
IN

INSTR

TYPE:
String Function

SYNTAX:
INSTR(<offset index,>string, search string<,wild card char>)

DESCRIPTION:
Searches the input string looking for the search string and returns the (zero based) index of the first occurrence of the string or -1 if the string is not found.

PARAMETERS:

Offset index:	An integer offset into the string being searched
string:	String to be searched
Search string:	Search string to look for
Wild card char:	A single wild card character to use within the search string expressed as a single character string or as a numerical **ASCII** value

EXAMPLES:

EXAMPLE:
Pre-define a variable of type string and search it for various sub-strings:

```
    DIM str1 AS STRING(32)
    str1 = "TRIO MOTION TECHNOLOGY"
    PRINT INSTR(str1, "MOTION") 'value = 5
    PRINT INSTR(6, str1, "MOTION") 'value = -1
    PRINT INSTR("Value = 123.45E10", "###.##E##", "#") 'Value = 8
    PRINT INSTR("this is my string", "is *y", 42) 'Value = 5
    PRINT INSTR(3, str1, "IO") 'Value = 8
```

SEE ALSO:

`CHR, STR, VAL, LEFT, RIGHT, MID, LEN, LCASE, UCASE`

INT

TYPE:

Mathematical Function

SYNTAX:

`value = INT(expression)`

DESCRIPTION:

The INT function returns the integer part of a number.

To round a positive number to the nearest integer value take the **`INT`** function of the (number + 0.5)

PARAMETERS:

expression:	Any valid TrioBASIC expression.
value:	The integer part of the expression

EXAMPLES:

EXAMPLE 1:

Print the integer part of a number on the command line

```
    >>PRINT INT(1.79)
    1.0000
    >>
```

EXAMPLE 2:

Round a value to the nearest integer.

```
    IF value>0 THEN
      rounded = INT(value + 0.5)
    ELSE
      rounded = INT(value - 0.5)
    ENDIF
```

INTEGER_READ

TYPE:
Mathematical Command

SYNTAX:
`INTEGER_READ(source, least_significant, most_significant)`

DESCRIPTION:
`INTEGER_READ` performs a low level access to the 64 bit register splitting it into two 32 bit segments.

This can be used to read the position from high resolution encoders

PARAMETERS:

source:	2 bit value that will be read, can be **VR**, **TABLE**, or system variable.
least_significant:	The variable to store the least significant (rightmost) 32 bits, this may be local variable, **VR** or **TABLE**
most_significant:	The variable to store the most significant (leftmost) 32 bits, this may be local variable, **VR** or **TABLE**

INTEGER_WRITE

TYPE:
Mathematical Command

SYNTAX:
`INTEGER_WRITE(destination, least_significant, most_significant)`

DESCRIPTION:
`INTEGER_WRITE` performs a low level write to a 64 bit register by combining two 32 bit segments.

PARAMETERS:

destination:	64 bit value that will be written, can be **VR**, **TABLE**, or system variable.
least_significant:	Least significant (rightmost) 16 bits, can be any valid TrioBASIC expression.
most_significant:	Most significant (leftmost) 16 bits, can be any valid TrioBASIC expression.

INTERP_FACTOR

TYPE:

Axis parameter

DESCRIPTION:

This parameter excludes the axis from the interpolated motion calculations so that it will become a following axis. This means that you can create an interpolated x,y move with z completing its movement over the same time period. The interpolated speed is calculated using any axes that have **INTERP_FACTOR** enabled. This means that at least one axis must be enabled and have a distance in the motion command otherwise the calculated speed will be zero and the command will complete immediately with no movement.

INTERP_FACTOR only operates with **MOVE**, **MOVEABS** and **MHELICAL** (on the 3rd axis) and their SP versions. All other motion commands require interpolated axes and so ignore this parameter.

EXAMPLE:

It is required to move a 'z' axis interpolated with x and y however we want the interpolated speed to only be active on the 'x,y' move. We disable the z axis from the interpolation group using **INTERP_FACTOR**. Remember when the movement is complete you must enable **INTERP_FACTOR** again.

```
    BASE(2)
    INTERP_FACTOR=0

    'Perform movement
    BASE(0,1,2)
    MOVEABS(x_offset, y_offset, z_offset)

    WAIT IDLE
    INTERP_FACTOR AXIS(2) = 1
```

INVERT_IN

TYPE:

System Function

SYNTAX:

`INVERT_IN(input, state)`

DESCRIPTION:

The **INVERT_IN** command allows the input channels to be individually inverted in software.

This is important as these input channels can be assigned to activate functions such as feedhold.

PARAMETERS:

input:	The input to invert	
state:	ON	the input is inverted in software
	OFF	the input is not inverted

EXAMPLE:

Invert input 7 so that when the input is low the **FWD_JOG** is off

```
INVERT_IN(7,ON)
FWD_JOG=7
```

INVERT_STEP

TYPE:

Axis Parameter

DESCRIPTION:

INVERT_STEP is used to switch a hardware inverter into the stepper pulse output circuit. This can be necessary for connecting to some stepper drives. The electronic logic inside the *Motion Coordinator* stepper pulse generation assumes that the **FALLING** edge of the step output is the active edge which results in motor movement. This is suitable for the majority of stepper drives.

INVERT_STEP should be set with **WDOG=OFF**.

If the setting is incorrect, a stepper motor may lose position by one step when changing direction.

VALUE:

ON	**RISING** edge of the step signal the active edge
OFF	**FALLING** edge of the step signal the active edge (default)

EXAMPLE:

Set **INVERT_STEP** for axis 2 as part of a startup routine.

```
BASE(2)
INVERT_STEP = ON
```

IO_STATUS

TYPE:
System Function

SYNTAX:
value = IO_STATUS(slot, address, vr_index [, status_index])

DESCRIPTION:
This command reads the status of a remote IO device on EtherCAT.

Status bit representation depends on the device implementation.

PARAMETERS:

value:	-1	Success
	0	Failure
slot:	The slot which the Ethercat IO module is connected	
address:	Network address of the IO device from which the status is read.	
vr_index:	-1	Print to the terminal
	>=0	Index of the **VR** where the status is stored
status_index	Index of the status being read (default 0).	

An Omron “block-type” device has one general status value for all IO so only status_index 0 is valid. A Beckhoff E-bus device has one status value per channel/point. Therefore for each channel the status can be read by using the status index. Here the valid range of status_index is 0..(number of channels -1).

IO_STATUSMASK

TYPE:
System Function

SYNTAX:
value = IO_STATUSMASK(slot, address, read_write, vr_index or mask value [, status index])

DESCRIPTION:
This command reads or writes the status mask of a remote Ethercat IO device. With a status mask system,

errors triggered by an **IO_STATUS** of a device can be masked out thus preventing a **SYSTEM_ERROR**. If the same bit is set in **IO_STATUS** and **IO_STATUSMASK** on the same device, a system error is triggered.

Status bit representation depends on the device implementation.

PARAMETERS:

value:	-1	Success
	0	Failure
slot:	The slot which the Ethercat IO module is connected	
address:	Network address of the IO device from which the status is read.	
Function:	0	Read status mask
	1	Write status mask

An Omron "block-type" device has one general status value for all **IO** so only status_index 0 is valid. A Beckhoff E-bus device has one status value per channel/point. Therefore for each channel the status can be read by using the status index. Here the valid range of status_index is 0..(number of channels -1).

IOMAP

TYPE:
System Command (command line only)

SYNTAX:
IOMAP

DESCRIPTION:
Lists the current Digital IO map.

EXAMPLE:
```
    >> IOMAP
    Digital Input map :
         0-   7 : Built-in Inputs
         8-  15 : Built-in Bi-Directional IO
        16-  31 : CAN P318 @ Address 0 (fw=v1.3.0)
        32-1023 : Virtual

    Digital Output map :
         0-   7 : Virtual
         8-  15 : Built-in Bi-Directional IO
        16-  31 : CAN P327 @ Address 0 (fw=v1.3.0)
        32-1023 : Virtual
```

IP_ADDRESS

TYPE:

System Parameter (**MC_CONFIG** / **FLASH**)

DESCRIPTION:

IP_ADDRESS is used to set the Ethernet IPv4 address of the main Ethernet port of the *Motion Coordinator*. This parameter uses the standard dot (.) notation to define the 4 separate octets of the IP address.

The value is held in flash EPROM and can be set in the **MC_CONFIG** script.

VALUE:

Network IP address in dot (.) format.

EXAMPLES:

EXAMPLE 1:

```
    IP_ADDRESS = 192.168.0.250
```

EXAMPLE 2:

Set IP address in the **MC_CONFIG** file

```
    ' MC_CONFIG script file
    IP_ADDRESS=192.168.2.100
```

IP_GATEWAY

TYPE:

System Parameter (**MC_CONFIG** / **FLASH**)

DESCRIPTION:

IP_GATEWAY is used to set the Ethernet network gateway address of the main Ethernet port of the *Motion Coordinator*. The Gateway is the IPv4 address of the internet access router on the factory network. It is only required if the *Motion Coordinator* is to be accessed via the internet. This parameter uses the standard dot (.) notation to define the 4 separate octets of the IP gateway address.

The value is held in flash EPROM and can be set in the **MC_CONFIG** script.

VALUE:
Network gateway address in dot (.) format.

EXAMPLES:

EXAMPLE 1:
```
IP_GATEWAY = 192.168.0.254
```

EXAMPLE 2:
Set IP gateway in the **MC_CONFIG** file
```
' MC_CONFIG script file
IP_GATEWAY=192.168.0.254
```

IP_MAC

TYPE:
System Parameter (**FLASH** / Read-only)

DESCRIPTION:
IP_MAC returns the configured MAC address of the main Ethernet port of the *Motion Coordinator*. The MAC address is set once at manufacture and is unique to that controller.

The value is held in flash EPROM and is normally read-only. If write access is available on older versions of firmware, do not change the MAC address under any circumstances without first consulting Trio.

VALUE:
Ethernet MAC address as a single 48 bit number.

EXAMPLES:

EXAMPLE 1:
```
>>PRINT IP_MAC
27648852217.0000
>>
```

EXAMPLE 2:
Get the MAC address in hexadecimal format
```
>>?hex(ip_mac)
6700000F9
>>
```
Converted to the 6 Octets format this is: 00 06 70 00 00 F9

IP_MEMORY_CONFIG

TYPE:
System Parameter (**`MC_CONFIG`**)

DESCRIPTION:
The MC464 Ethernet port has memory allocated to buffer the incoming and outgoing data telegrams. Each buffer page uses 1600 bytes of memory. If some ports are turned off using **`IP_PROTOCOL_CONFIG`**, then **`IP_MEMORY_CONFIG`** may be used to re-allocate the unused memory and give a larger buffer size to the incoming and outgoing data.

By default there are 2 x 1600 bytes allocated to Tx and 2 x 1600 allocated to Rx. The value of **`IP_MEMORY_CONFIG`** is $22. (or 2 + 32 in decimal) In most networks this buffer size is enough to handle all the network traffic.

VALUE:

The **`IP_MEMORY_CONFIG`** is a byte which is split into 2 nibbles.

Bits	Description	Value
0 - 3	Size of Rx buffer; number of 1600 byte pages.	\$01 to \$09
4 - 7	Size of Tx buffer; number of 1600 byte pages.	\$10 to \$90

Do not set either nibble to less than 1 otherwise there will be no memory allocated and *Motion* Perfect will not be usable.

EXAMPLE:
Allocate more buffer space for incoming Rx Ethernet traffic to cope with frequent broadcast telegrams on a busy network.

```
' Disable Ethernet IP and text file loader ports
IP_PROTOCOL_CONFIG = $37
' Allocate the freed memory space to Rx net-buffer
IP_MEMORY_CONFIG = $29
```

IP_NETMASK

TYPE:
System Parameter (**`MC_CONFIG`** / **`FLASH`**)

DESCRIPTION:

`IP_NETMASK` is used to set the Ethernet IPv4 subnet mask of the main Ethernet port of the *Motion Coordinator*. This parameter uses the standard dot (.) notation to define the 4 separate octets of the IP subnet mask.

The value is held in flash EPROM and can be set in the **`MC_CONFIG`** script.

VALUE:

Network subnet mask in dot (.) format.

EXAMPLES:

EXAMPLE 1:

```
    IP_NETMASK = 255.255.255.0
```

EXAMPLE 2:

Set IP subnet mask in the **`MC_CONFIG`** file

```
    ' MC_CONFIG script file
    IP_NETMASK=255.255.255.0
```

IP_PROTOCOL_CONFIG

TYPE:

System Parameter (**`MC_CONFIG`**)

DESCRIPTION:

The MC464 is limited to 7 communication ports on Ethernet, **`IP_PROTOCOL_CONFIG`** allows the user to select which ports they would like to use.

By default all ports except the transparent protocol text file loader port are enabled. It is recommended to use the MC4xx protocol which is enabled by default.

VALUE:

Up to 7 bits can be selected, the default value is 575 ($23F).

Bit	Description	Value
0	*Motion* Perfect (Telnet)	1
1	PCMotion	2
2	Modbus	4

Bit	Description	Value
3	EthernetIP	8
4	IEC61131-3 programming	16
5	Uniplay	32
6	Transparent protocol text file loader	64
7	Reserved bit	128
8	Reserved bit	256
9	MC4xx protocol text file loader	512

Do not disable bit 0 otherwise the command line and *Motion* Perfect will not be usable.

EXAMPLE:
Enable the standard ports using bits 0-5 and the transparent protocol text file loader ports.

```
    IP_PROTOCOL_CONFIG = 1+2+4+8+16+32+64
    ` or
    IP_PROTOCOL_CONFIG = $7F
```

IP_PROTOCOL_CTRL

TYPE:
System Parameter (**MC_CONFIG**)

DESCRIPTION:
This parameter mirrors the **IP_PROTOCOL_CONFIG** bit pattern to allow the user to disable the operation of one or more of the MC464 communication ports on Ethernet. If a bit is at 0, the port is enabled. If the bit is a 1, then the port is disabled and will not respond when a client tries to open it.

By default all ports are enabled.

VALUE:
Up to 2 bits can be selected, the default value is 0.

Bit	Description	Value
0	*Motion* Perfect (Telnet)	n/a
1	PCMotion	n/a
2	Modbus	4

Bit	Description	Value
3	EthernetIP	8
4	IEC61131-3 programming	n/a
5	Uniplay	n/a
6	Transparent protocol text file loader	n/a
7	Reserved bit	n/a
8	Reserved bit	n/a
9	MC4xx protocol text file loader	n/a

It is not possible to disable any port marked as n/a.

EXAMPLE 1:

Disable the Modbus TCP port until it has been set up for 32 bit data size in the **BASIC** startup program.

a) In the MC_**CONFIG** set:

```
IP_PROTOCOL_CTRL = 4
```

b) In the Startup BASIC program set:

```
ETHERNET(1, -1, 14, 0, 2, 1) ‘ 32 bit integer support
ETHERNET(1, -1, 14, 0, 1, 4) ‘ data to/from TABLE memory
ETHERNET(1, -1, 14, 0, 6, 1) ‘ Use “Address Halving”

IP_PROTOCOL_CTRL = 0 ‘ start the Modbus TCP protocol
```

EXAMPLE 2:

Disable the Ethernet IP port until the data end-points have been set up in the **BASIC** startup program.

a) In the MC_**CONFIG** set:

```
IP_PROTOCOL_CTRL = 8
```

b) In the Startup BASIC program set:

```
 ‘--Config *PLC INPUT* Instance (100), data to PLC from Trio.
ETHERNET(1, -1, 14, 1, 0, 200) ‘200 = set VR starting address
ETHERNET(1, -1, 14, 1, 1, 3) ‘3 = use VR for data location
ETHERNET(1, -1, 14, 1, 2, 1) ‘1 = use 32 bit integer data
ETHERNET(1, -1, 14, 1, 3, 120) ‘120 = number of data values

 ‘--Config *PLC OUTPUT* Instance (101), data from PLC to Trio.
ETHERNET(1, -1, 14, 2, 0, 400) ‘400 = set VR starting address
ETHERNET(1, -1, 14, 2, 1, 3) '3 = use VR for data location
ETHERNET(1, -1, 14, 2, 2, 1) '1 = use 32 bit integer data
ETHERNET(1, -1, 14, 2, 3, 120) '120 = number of data values

'-------------------------------------------------------------

IP_PROTOCOL_CTRL = 0 'enable Ethernet IP
```

IP_TCP_TIMEOUT

TYPE:
System Parameter (**MC_CONFIG**, MC464 only)

DESCRIPTION:
IP_TCP_TIMEOUT defines the time period (in msec) for which the TCP connections (EtherNet/IP, ModbusTCP, HMI, Token and Telnet) will stay open without any activity. When this period is exceeded, the TCP connection will be closed by the controller. The default is 3600 seconds.) The parameter must be in the **MC_CONFIG** to be effective.

VALUE:

Size	Bits	Value (hexadecimal)	Function
Long word	Bit 0..11	$0000000000000ttt	Telnet TCP timeout
	Bits 12..23	$0000000000ttt000	Token system timeout
	Bits 24..35	$0000000ttt000000	Modbus TCP timeout
	Bits 36..47	$0000ttt000000000	Ethernet IP timeout
	Bits 48..59	$0ttt000000000000	Uniplay HMI channel timeout
	Bits 60..63	$x000000000000000	Not used

Setting this value away from the default may make the connection to *Motion* Perfect unstable.

Each 12 bits of this value sets the timeout period (in seconds) for that part of the Ethernet. If it is left at 0, then it becomes the default of 3600 seconds.

There is also a built-in timeout in the Ethernet stack. The default is approximately 8 seconds, so when you set the value in **IP_TCP_TIMEOUT** to 2 seconds, the total is 10.

EXAMPLE 1:

Force the Ethernet processor to close the Modbus TCP socket after 20 seconds when there is no activity from the master. This enables the master to re-open the connection and continue after a break in communications.

```
    ' Modbus socket will close after 20 seconds (12 + 8)
    IP_TCP_TIMEOUT = $00C000000
```

EXAMPLE 2:

Set the Ethernet processor to close the Ethernet IP TCP socket after 12 seconds when there is no activity from the master. This enables the master to re-open the connection and continue after a break in communications.

```
    ' Modbus socket will close after 12 seconds (4 + 8)
    IP_TCP_TIMEOUT = $004000000000
```

IP_TCP_TX_THRESHOLD

TYPE:

System Parameter (**MC_CONFIG**)

DESCRIPTION:

IP_TCP_TX_THRESHOLD defines the number of bytes in the TCP socket transmit buffer which will trigger a telegram transmit. The default is 32. This value applies to all the TCP protocols.

VALUE:

Please consult Trio before changing this value.

Size	Description	Value	Default
word	Number of bytes in TCP socket transmit buffer which triggers a transmission.	1 to 1023	32

Setting this value away from the default may make the connection to *Motion* Perfect unstable.

EXAMPLE:

Force the Ethernet processor to transmit TCP packets immediately when the data size is small, so as not to wait for the timeout before sending.

```
    IP_TCP_TX_THRESHOLD = 16
```

IP_TCP_TX_TIMEOUT

TYPE:
System Parameter (**`MC_CONFIG`**)

DESCRIPTION:
`IP_TCP_TX_TIMEOUT` defines the time period (in msec) at which a TCP telegram will be transmitted after receiving the first byte if the number of bytes threshold is not reached. The default is 20msec. This value applies to all the TCP protocols.

VALUE:

Please consult Trio before changing this value.

Size	Description	Value	Default
Long word	Time after which telegram will be transmitted if the data size threshold is not reached. (milliseconds)	1 to 2^32-1	20

Setting this value away from the default may make the connection to *Motion* Perfect unstable.

EXAMPLE:
Force the Ethernet processor to transmit TCP packets only after 1 second when the data size threshold is not reached.

```
    IP_TCP_TX_TIMEOUT = 1000
```

JOGSPEED

TYPE:
Axis Parameter

DESCRIPTION:
Sets the jog speed in user units for an axis to run at when performing a jog.

You can set a faster jog speed using **`SPEED`** and the **`FAST_JOG`** input

VALUE:
The speed in user **`UNITS`**/second which an axis will use when being jogged

EXAMPLE:

Configure an input to be the jog input at 20mm/sec on axis 12

```
BASE(12)
SPEED=3000
FWD_JOG = 12
JOGSPEED = 20
```

SEE ALSO:

FAST_JOG, FWD_JOG, REV_JOG

KEY

TYPE:

System Function.

SYNTAX:

value = KEY [#channel]

DESCRIPTION:

Key is used to check if there are characters in a channel buffer. This command does not read the character but allows the program to test if any character has arrived.

A **TRUE** result will be reset when the character is read with **GET**.

PARAMETERS:

#channel:	See # for the full channel list (default 0 if omitted)
value:	A negative value representing the number of characters in the channel buffer

EXAMPLE:

Call a subroutine if a character has been received on channel 1

```
main:
  IF KEY#1 THEN GOSUB read
...
read:
  GET#1 k
RETURN
```

SEE ALSO:

GET

LAST_AXIS

TYPE:
System Parameter

DESCRIPTION:
The *Motion coordinator* keeps a list of axes that are currently in use. **`LAST_AXIS`** is used to read the number of the highest axis in the list.

`LAST_AXIS` is set automatically by the system software when an axis is written to; this can include setting **`BASE`** for the axis.

Axes higher than **`LAST_AXIS`** are not processed. Not all axis lower than **`LAST_AXIS`** are processed.

VALUE:
The highest axis in the axis list that is processed.

EXAMPLE:
Check **`LAST_AXIS`** to ensure that the digital network has configured enough drives.

```
IF LAST_AXIS <> 26 THEN
  PRINT#user, “Digital Drives not initialised”
ENDIF
```

LCASE

TYPE:
String Function

SYNTAX:
`LCASE(string)`

DESCRIPTION:
Returns a new string with the input string converted to all lower case.

PARAMETERS:

string:	String to be used

EXAMPLES:

EXAMPLE 1:

Pre-define a variable of type string and later print it in all lower case characters:

```
    DIM str1 AS STRING(32)
    str1 = "TRIO MOTION TECHNOLOGY"
    PRINT LCASE(str1)
```

SEE ALSO:

CHR, STR, VAL, LEFT, RIGHT, MID, LEN, UCASE, INSTR

LCDSTR

TYPE:

String Function

SYNTAX:

LCDSTR = string

DESCRIPTION:

Allows the currently displayed character string on display to be read from or written to when under user control. This will only be allowed when the display is in normal display mode, for example if the user removes and replaces the EtherNET cable then the displaying of IP address data will take priority before returning to the previous display string again.

This function is available on the MC405 only.

VALUE:

The string is predefined with a length of 3 and reflects the currently displayed 7-segment characters.

EXAMPLES:

EXAMPLE 1:

Take user control of 7-segement characters and display integer value of **VR**(100).

```
    DISPLAY.16 = 1 'Enable user control of 7-segment chars
    vr(100) = -88
    LCDSTR = STR(VR(100),0,3)
```

SEE ALSO:

DISPLAY

LEFT

TYPE:
String Function

SYNTAX:
`LEFT(string, length)`

DESCRIPTION:
Returns the left most section of the specified string using the length specified.

PARAMETERS:

string:	String to be used
length:	Length of string to be returned

EXAMPLES:

EXAMPLE 1:
Pre-define a variable of type string and later print its left most 4 characters:

```
    DIM str1 AS STRING(32)
    str1 = "TRIO MOTION TECHNOLOGY"
    PRINT LEFT(str1, 4)
```

SEE ALSO:
CHR, STR, VAL, RIGHT, MID, LEN, LCASE, UCASE, INSTR

LEN

TYPE:
String Function

SYNTAX:
`LEN(string)`

DESCRIPTION:
Returns length of the specified string

PARAMETERS:

string:	String to be measured.

EXAMPLES:

EXAMPLE 1:
Pre-define a variable of type string and later determine its length:

```
    DIM str1 AS STRING(20)
    Str1="MyString"
    x=LEN(str1) ' x will be 8
```

SEE ALSO:
CHR, STR, VAL, LEFT, RIGHT, MID, LCASE, UCASE, INSTR

< Less Than

TYPE:
Comparison Operator

SYNTAX:
<expression1> < <expression2>

DESCRIPTION:
Returns **TRUE** if expression1 is less than expression2, otherwise returns **FALSE**.

PARAMETERS:

Expression1:	Any valid TrioBASIC expression
Expression2:	Any valid TrioBASIC expression

EXAMPLE:
Check that the value from analogue input 1 is less than 10, if it is then execute the sub routine 'rollup'.

```
    IF AIN(1)<10 THEN GOSUB rollup
```

<= Less Than or Equal

TYPE:
Comparison Operator

SYNTAX:
`<expression1> <= <expression2>`

DESCRIPTION:
Returns **`TRUE`** if expression1 is less than or equal to expression2, otherwise returns **`FALSE`**.

PARAMETERS:

Expression1:	Any valid TrioBASIC expression
Expression2:	Any valid TrioBASIC expression

EXAMPLE:
1 is not less than or equal to 0 and therefore variable maybe holds the value 0 (**`FALSE`**)

```
    maybe=1<=0
```

LIMIT_BUFFERED

TYPE:
System Parameter

DESCRIPTION:
This sets the maximum number of move buffers available in the controller.

You can increase the machine speed when using *MERGE* or *CORNER_MODE* by increasing the number of buffers.

VALUE:

1..64	The number of move buffers (default = 1)

EXAMPLE:
Configure the *Motion Coordinator* to have 10 move buffers so a large sequence of small moves can be merged together.

```
    LIMIT_BUFFERED = 10
```

_ (Line Continue)

TYPE:
Special Character

SYNTAX:
```
ExpressionStart _
ExpressionEnd
```

DESCRIPTION:
The line extension allows the user to split a long expression or command over more than one lines in the TrioBASIC program.

The split must be at the end of a parameter or keyword.

PARAMETERS:

ExpressionStart:	The start of the command or expression.
ExpressionEnd:	The end of the command or expression.

EXAMPLE:
Split the **SERVO_READ** command over 2 lines so you can use all 8 parameters.
```
    SERVO_READ(123, MPOS AXIS(0), MPOS AXIS(1), MPOS AXIS(2), _
    MPOS AXIS(3), MPOS AXIS(4), MPOS AXIS(5), MPOS AXIS(6))
```

LINK_AXIS

TYPE:
Axis Parameter (Read Only)

ALTERNATIVE FORMAT:
LINKAX

DESCRIPTION:
Returns the axis number that the axis is linked to during any linked moves.

Linked moves are where the demand position is a function of another axis e.g. *CONNECT*, *CAMBOX*, *MOVELINK*

VALUE:

-1	Axis is not linked
Number	Axis number the **BASE** axis is linked to

EXAMPLE

CONNECT an axis , then check that it is linked.

```
    >>BASE(0)
    >>CONNECT(12,4)
    >>PRINT LINK_AXIS
    4.0000
    >>
```

LINPUT

TYPE:

System Command

SYNTAX:

LINPUT [#channel,] variable

DESCRIPTION:

Waits for an input string and stores the **ASCII** values of the string in an array of variables starting at a specified numbered variable. The string must be terminated with a carriage return <CR> which is also stored. The string is not echoed by the controller.

You can print the string from the VRs using **VRSTRING**

PARAMETERS:

#channel:	See # for the full channel list (default 0 if omitted)
variable:	The **VR** variable to store the received character

EXAMPLE:

Use **LINPUT** to receive a string of characters on channel 5 and place then into a series of **VR**s starting at **VR**(0)

```
    LINPUT#5, VR(0)
```

Now entering: **START**<CR> on channel 5 will give:

```
    VR(0)    83    ASCII 'S'
    VR(1)    84    ASCII 'T'
    VR(2)    65    ASCII 'A'
    VR(3)    82    ASCII 'R'
    VR(4)    84    ASCII 'T'
    VR(5)    13    ASCII carriage return
```

SEE ALSO:
`#, CHANNEL_READ, VRSTRING`

LIST

TYPE:
System Command (command line only)

SYNTAX:
`LIST ["program"]`

DESCRIPTION:
Prints the current **`SELECTed`** program or a specified program to the current output channel.

Usually you will view a program by using *Motion* Perfect.

PARAMETERS:

none:	Prints the selected program
program:	The name of the program to print

LIST_GLOBAL

TYPE:
System Command (command line only)

SYNTAX:
`LIST_GLOBAL`

DESCRIPTION:
Prints all the **`GLOBAL`** and **`CONSTANT`**s to the current output channel

EXAMPLE:
Check all global data in an application where the following **GLOBAL** and **CONSTANT** have been set.

```
    CONSTANT "cutter", 23
    GLOBAL "conveyor",5

    >>LIST_GLOBAL
    Global                           VR
    ----------------                 ----
    conveyor                         5
    Constant                         Value
    ----------------                 -------
    cutter                           23.00000
    >>
```

LN

TYPE:
Mathematical Function

SYNTAX:
value = LN(expression)

DESCRIPTION:
Returns the natural logarithm of the expression.

PARAMETER:

value:	The natural logarithm f the expression
expression:	Any valid TrioBASIC expression.

EXAMPLE:
Storing the natural logarithm of a value in **VR**(0)

```
    VR(0) = LN(a*b)
```

LOAD_PROJECT

TYPE:
System Command

DESCRIPTION:

Used by *Motion* Perfect to load projects to the controller.

If you wish to load projects outside of *Motion* Perfect use the Autoloader ActiveX

LOADED

TYPE:

Axis Parameter

DESCRIPTION:

Checks if all the movements have been loaded into the **MTYPE** buffer so will return a **TRUE** value when there are no buffered movements.

Although it is possible to use **LOADED** as part of any expression it is typically used with a *WAIT*.

VALUE:

TRUE	when there are no buffered moves
FALSE	when there are buffered moves.

EXAMPLE:

Continue to load a sequence of moves when the **NTYPE** buffer is free

```
WHILE machine_on =TRUE
  WAIT UNTIL LOADED or machine_off=FALSE
  IF machine_on=TRUE THEN
    MOVE(TABLE(position)
    position=position+1
  ENDIF
WEND
```

SEE ALSO:

MOVES_BUFFERED, WAIT

LOADSYSTEM

TYPE:

System Command

DESCRIPTION:

Used by *Motion* Perfect to load Firmware to the controller

If you wish to load firmware without *Motion* Perfect you can use the SD card (**`FILE`** command)

SEE ALSO:

`FILE`

LOCK

TYPE:

System Command (command line only)

SYNTAX:

`LOCK(code)`

DESCRIPTION:

The **`LOCK`** copmmand is designed to prevent programs from being viewed or modified by personnel unaware of the security code. The lock code number is stored in the flash EPROM.

When a *Motion Coordinator* is locked, it is not possible to view, edit or save any programs and command line instructions are limited to those required to execute the program. The **`CONTROL`** value has 1000 added to it when the controller is **`LOCK`**ed.

You should use *Motion* Perfect to **`LOCK`** and **`UNLOCK`** your controller.

To unlock the *Motion Coordinator*, the **`UNLOCK`** command should be entered using the same lock code number which was used originally to **`LOCK`** it.

The lock code number may be any integer and is held in encoded form. Once **`LOCK`**ed, the only way to gain full access to the *Motion Coordinator* is to **`UNLOCK`** it with the correct code. For best security the lock number should be 7 digits.

It is possible to compromise the security of the lock system. Users must consider if the level of security is sufficient to protect their programs. If you want better security consider encrypting your project.

If you forget the security code number, the *Motion Coordinator* may have to be returned to your supplier to be unlocked.

PARAMETERS:

code:	Any 7 digit integer number

SEE ALSO:

`UNLOCK`

LOOKUP

TYPE:

Process Command

SYNTAX:

`LOOKUP(format,entry) <PROC(process#)>`

DESCRIPTION:

The **`LOOKUP`** command is used by *Motion* Perfect to access the local variables on an executing process.

You should use the variable watch window in *Motion* Perfect to access the variables on an executing process.

PARAMETERS:

format:	0	Prints (in binary) floating point value from an expression
	1	Prints (in binary) integer value from an expression
	2	Prints (in binary) local variable from a process
	3	Returns to **`BASIC`** local variable from a process
	4	Write
entry:	Either an expression string (format=0 or 1) or the offset number of the local variable into the processes local variable list.	

MARK

TYPE:
Axis Parameter (Read Only)

DESCRIPTION:
This parameter can be polled to determine if the registration event has occurred.

MARK is reset when **REGIST** is executed

VALUE:

FALSE	The registration event has not occurred
TRUE	The registration event has occurred (default)
< -1	Quantity of registration events have been logged to the **TABLE**

When **TRUE** the **REG_POS** is valid.

EXAMPLE:
Apply an offset to the position of the axis depending on the registration position.

```
loop:
  WAIT UNTIL IN(punch_clr)=ON
  MOVE(index_length)
  REGIST(20, 0, 0, 0, 0) 'rising edge of R
  WAIT UNTIL MARK
  MOVEMODIFY(REG_POS + offset)
  WAIT IDLE
GOTO loop
```

SEE ALSO:
REGIST, REG_POS

MARKB

TYPE:
Axis Parameter (Read Only)

DESCRIPTION:
This parameter can be polled to determine if the registration event has occurred on the second registration

channel.

MARKB is reset when **REGIST** is executed

VALUE:

FALSE	The registration event has not occurred
TRUE	The registration event has occurred (default)
< -1	Quantity of registration events have been logged to the **TABLE**

When **TRUE** the **REG_POSB** is valid.

SEE ALSO

REGIST, REG_POSB

MERGE

TYPE:

Axis Parameter

DESCRIPTION:

Velocity profiled moves can be MERGEd together so that the speed will not ramp down to zero between the current move and the buffered move.

It is up to the programmer to ensure that the merging is sensible. For example merging a forward move with a reverse move will cause an attempted instantaneous change of direction.

MERGE will only function if:

- The next move is loaded into the buffer
- The axis group does not change on multi-axis moves

Velocity profiled moves (**MOVE**, **MOVEABS**, **MOVECIRC**, **MHELICAL**, **REVERSE**, **FORWARD**) cannot be merged with linked moves (**CONNECT**, **MOVELINK**, **CAMBOX**)

When merging multi-axis moves only the base axis **MERGE** flag needs to be set.

If you are merging short moves you may need to increase the number of buffered moves by increasing **LIMIT_BUFFERED**

VALUE:

ON	motion commands are merged
OFF	motion commands decelerate to zero speed

EXAMPLE:

Turn on **MERGE** before a sequence of moves, then disable at the end.

```
    BASE(0,1) 'set base array
    MERGE=ON 'set MERGE state
    MOVEABS(0,50) 'run a sequence of moves
    MOVE(0,100)
    MOVECIRC(50,50,50,0,1)
    MOVE(100,0)
    MOVECIRC(50,-50,0,-50,1)
    MOVE(0,-100)
    MOVECIRC(-50,-50,-50,0,1)
    MOVE(-100,0)
    MOVECIRC(-50,50,0,50,1)
    WAIT IDLE
    MERGE=OFF
```

MHELICAL

TYPE:

Axis Command.

SYNTAX:

```
MHELICAL(end1, end2, centre1, centre2, direction, distance3 [,mode])
```

ALTERNATE FORMAT:

```
MH()
```

DESCRIPTION:

Performs a helical move.

Moves 2 orthogonal axes in such a way as to produce a circular arc at the tool point with a simultaneous linear move on a third axis. The first 5 parameters are similar to those of an **MOVECIRC** command. The sixth parameter defines the simultaneous linear move.

PARAMETERS:

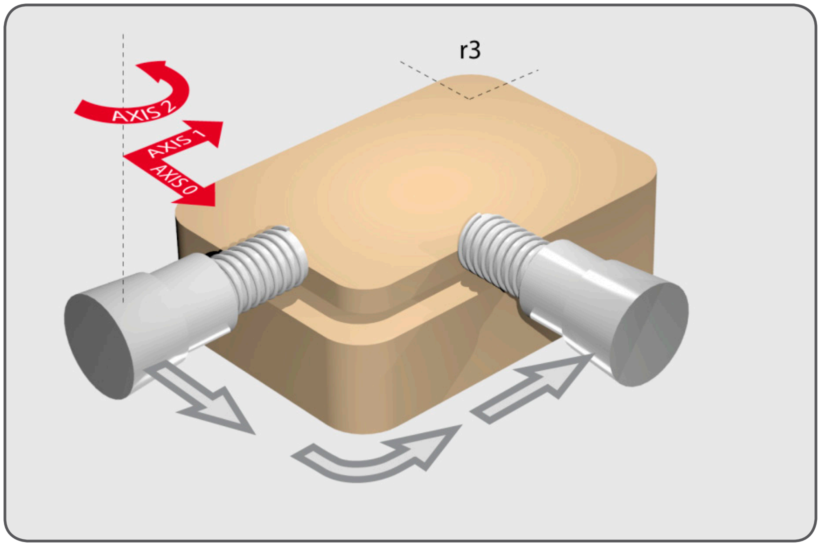
end1:	position on **BASE** axis to finish at.	
end2:	position on next axis in **BASE** array to finish at.	
centre1:	position on **BASE** axis about which to move.	
centre2:	position on next axis in **BASE** array about which to move.	
direction:	0	Arc is interpolated in an anti-clockwise direction
	1	Arc is interpolated in a clockwise direction
distance3:	The distance to move on the third axis in the **BASE** array axis in user units	
mode:	0	Interpolate the 3rd axis with the main 2 axes when calculating path speed. (True helical path)
	1	Interpolate only the first 2 axes for path speed, but move the 3rd axis in coordination with the other 2 axes. (Circular path with following 3rd axis)

The first 4 distance parameters are scaled according to the current unit conversion factor for the *BASE* axis. The sixth parameter uses its own axis units.

EXAMPLES:

EXAMPLE1:

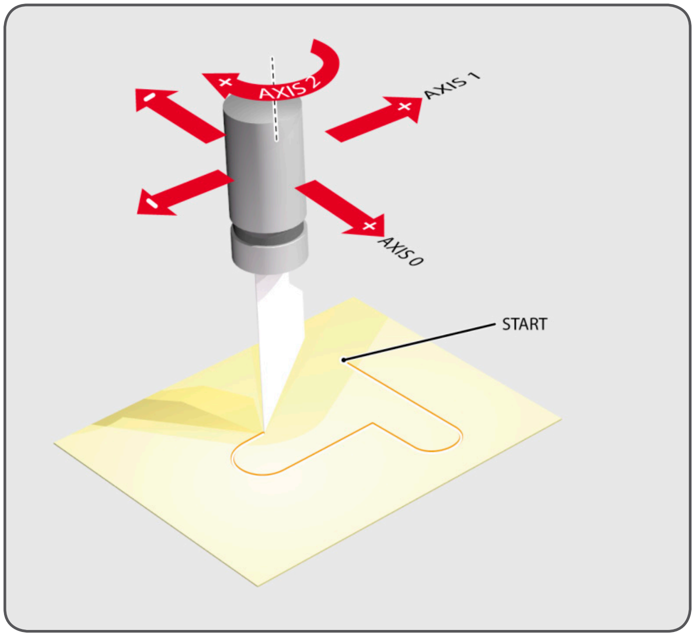
The command sequence follows a rounded rectangle path with axis 1 and 2. Axis 3 is the tool rotation so that the tool is always perpendicular to the product. The **UNITS** for axis 3 are set such that the axis is calibrated in degrees.



```
REP_DIST AXIS(3)=360
REP_OPTION AXIS(3)=ON 'all 3 axes must be homed before starting
MERGE=ON
MOVEABS(360) AXIS(3) 'point axis 3 in correct starting direction
WAIT IDLE AXIS(3)
MOVE(0,12)
MHELICAL(3,3,3,0,1,90)
MOVE(16,0)
MHELICAL(3,-3,0,-3,1,90)
MOVE(0,-6)
MHELICAL(-3,-3,-3,0,1,90)
MOVE(-2,0)
MHELICAL(-3,3,0,3,1,90)
```

EXAPMLE 2:

A PVC cutter uses 2 axis similar to a xy plotter, a third axis is used to control the cutting angle of the knife. To keep the resultant cutting speed for the x and y axis the same when cutting curves, mode 1 is applied to the helical command.



```
BASE(0,1,2) : MERGE=ON 'merge moves into one continuous movement
MOVE(50,0)
MHELICAL(0,-6,0,-3,1,180,1)
MOVE(-22,0)
WAIT IDLE
MOVE(-90) AXIS(2)     'rotate the knife after stopping at corner
WAIT IDLE AXIS(2)
MOVE(0,-50)
MHELICAL(-6,0,-3,0,1,180,1)
MOVE(0,50)
WAIT IDLE             'pause again to rotate the knife
MOVE(-90) AXIS(2)
WAIT IDLE AXIS(2)
MOVE(-22,0)
MHELICAL(0,6,0,3,1,180,1)
WAIT IDLE
```

SEE ALSO:

MOVECIRC

MHELICALSP

TYPE:
Axis Command.

SYNTAX:
`MHELICALSP(end1, end2, centre1, centre2, direction, distance3 [,mode])`

DESCRIPTION:
Performs a helical move the same as **MHELICAL** and additionally allows vector speed to be changed when using multiple moves in the buffer. Uses additional axis parameters **FORCE_SPEED**, **ENDMOVE_SPEED**. and **STARTMOVE_SPEED**.

EXAMPLE:
In a series of buffered moves using the look ahead buffer with **MERGE**=ON a helical move is required where the incoming vector speed is 40 **UNITS**/second and the finishing vector speed is 20 **UNITS**/second.

```
FORCE_SPEED=40
ENDMOVE_SPEED=20
MHELICALSP(100,100,0,100,1,100)
```

SEE ALSO:
MHELICAL

MID

TYPE:
STRING Function

SYNTAX:
`MID(string, start[, length])`

DESCRIPTION:
Returns the mid-section of the specified string using the optional length specified, or defaults to the remainder of the string when not specified.

PARAMETERS:

string:	String to be used
start	Start index of string

length:	Length of string to be returned, if not specified then the remainder of the string will be used

EXAMPLES:

EXAMPLE 1:
Pre-define a variable of type string and later print characters: from index 5 to 10

```
    DIM str1 AS STRING(32)
    str1 = "TRIO MOTION TECHNOLOGY"
    PRINT MID(str1, 5, 6)
```

SEE ALSO:
CHR, STR, VAL, LEN, LEFT, RIGHT, LCASE, UCASE, INSTR

MOD

TYPE:
Mathematical Operator

SYNTAX:
```
value = expression1  MOD(expression2)
```

DESCRIPTION:
Returns the integer modulus of an expression, this is the value after the integer has wrapped around the modulus

PARAMETERS:

value:	the modulus of expression 1
expression1:	Any valid TrioBASIC expression used as the value to apply the modulus to.
expression2:	Any valid TrioBASIC expression used as the modulus

EXAMPLE:
Use the MOD(12) to turn a 24 hour value into 12 hour.

```
    >>PRINT 18 MOD(12)
    6.0000
    >>
```

MODBUS

TYPE:
System Function

SYNTAX:
MODBUS(function, slot [, parameters…])

DESCRIPTION:
This function allows the user to configure the Ethernet port to run as a Modbus TCP Client (Master). Using the **MODBUS** command, the user can open a connection to a remote server, transfer data using a sub-set of Modbus Function Numbers and check for errors.

PARAMETERS:

function:	0	Open a ModbusTCP client connection
	1	Close connection
	2	Check connection status
	3	Send commands (Modbus functions)
	$10	Get Error Log Entry
	$11	Get Error Log Count

FUNCTION = 0;

SYNTAX:
value = MODBUS(0,slot , ip address 1...4 [, port number [,vr_index]])

DESCRIPTION:
Attempt to open a ModbusTCP client connection to the given remote server.

PARAMETERS:

value:	**TRUE** = the command was successful
	FALSE = the command was unsuccessful
slot:	Module slot in which the communication port is fitted

ip address:	Server's IP address as 4 octets separated by commas
port number:	Optional port number. Default is port 502 if none given.
vr_index:	Index number of the `VR` where the connection handle will be written. Default value is -1. -1 means print to the standard output stream. (normally terminal 0)

EXAMPLE:
```
    'IP Address 192.168.0.185, Port Number 502
    IF MODBUS(0,-1,192,168,0,185,502,20)=TRUE THEN
      PRINT "Modbus port opened OK"
      modbus_handle = VR(20)
    ELSE
      PRINT "Error, Modbus server not found"
    ENDIF
```

FUNCTION = 1:

SYNTAX:

`value = MODBUS(1,slot,handle)`

DESCRIPTION:

Close ModbusTCP client connection if open.

PARAMETERS:

value:	`TRUE`	the command was successful
	`FALSE`	the command was unsuccessful or the connection was already closed
slot:	Module slot in which the communication port is fitted	
handle:	number that was returned by the previous "open" function	

EXAMPLE:
```
    'Close Modbus connection
    MODBUS(1,-1,modbus_handle)
```

FUNCTION = 2:

SYNTAX:

`value = MODBUS(2, slot, handle [,VR index])`

DESCRIPTION:
Return connection status (0 = closed, 1 = open)

PARAMETERS:

value:	`TRUE`	the command was successful
	`FALSE`	the command was unsuccessful
slot:	Module slot in which the communication port is fitted	
handle:	number that was returned by the previous “open” function or 0 which checks for any open handle	
VR index:	VR number which will hold the returned value. If set to -1 or not included, then the value is printed to the command-line terminal	

EXAMPLE:

EXAMPLE 1
```
    'Is Modbus connection open?
    MODBUS(2, -1, 200)
    IF VR(200)=1 THEN
      PRINT “Modbus port is open”
    ELSE
      PRINT “Modbus port is closed”
    ENDIF
```

EXAMPLE 2
```
    >>MODBUS(2, -1, -1)
    1
```

FUNCTION = 3:

SYNTAX:
`value = MODBUS(3, slot, handle, modbus function code [, parameters])`

DESCRIPTION:
Execute the given Modbus function if the connection is open. The parameters vary depending upon the function required. Holding Registers are mapped to the corresponding **VR** in the client. IO functions use the **VR**s to hold the remote IO states when reading from the remote server, or as the IO source when writing to the remote server. Each **VR** entry is used to hold up to 32 IO bits. The Modbus functions supported are defined below.

PARAMETERS:

value:	**`TRUE`**	the command was successful
	`FALSE`	the command was unsuccessful
slot:	Module slot in which the communication port is fitted	
handle:	Handle of the previously opened connection	
Modbus function code:	A recognised valid Modbus function code number	
Other parameters:	See table below	

Function	#	Parameters	Notes
Read Coils	1	Start Address	
		Number of values	
		Result start address	VR index for response values
Read Discrete Inputs	2	Start Address	
		Number of values	
		Result start address	VR index for response values
Read Holding Registers	3	Start Address	Modbus register start address in Server. Data read is mapped directly to same **`VR`**s in the client unless Local Address is set.
		Number of values	
		Local Address	If set, this is the target **`VR`** start address in the *Motion Coordinator* client.
Read Input Registers	4	Start Address	Data read directly into **`VR`**s
		Number of values	
Write Single Coil	5	Address	
		Value	1 (on) or 0 (off)
Write Single Register	6	Address	Modbus register address in server. Value is taken from the same client **`VR`** unless Local Address is set.
		Local Address	If set, this is the target **`VR`** address in the *Motion Coordinator* client.

Function	#	Parameters	Notes
Write Multiple Coils	15	Start Address	
		Number of coils	
		Source address	VR start address containing required coil state values.
Write Multiple Registers	16	Start Address	Modbus register start address in server. Values are copied from the same **VR** address in the client unless the Local Address is set.
		Number of registers	
		Local Address	If set, this is the target **VR** start address in the *Motion Coordinator* client.
Read Write Multiple Registers	23	Read Start address	Mapped to same **VR**s in Client
		Number of Read registers	
		Write Start address	Mapped from same **VR**s in Client.
		Number of Write registers	

EXAMPLE

```
    my_slot=-1

    open_modbus = $00
    close_modbus = $01
    get_status = $02
    ex_modbus_func = $03
    get_error_log = $10


    ` check if Modbus is already open
    MODBUS(get_status, my_slot, 100)
    IF VR(100)=1 THEN
        ` close the connection so that it can be re-opened
        MODBUS(close_modbus, my_slot)
    ENDIF

    ` open the modbus server (remote slave) & put handle in VR(20)
    MODBUS(open_modbus, my_slot, 192,168,000,249,502,20)

    REPEAT
        ` get 10 values from holding registers 1000 to 1009
        MODBUS(ex_modbus_func, my_slot, VR(20), 3, 1000, 10)
        ` send 10 values to holding registers 1010 to 1019
        MODBUS(ex_modbus_func, my_slot, VR(20), 16, 1010, 10)
        WA(200)
    UNTIL FALSE
```

FUNCTION = $10:

SYNTAX:

MODBUS($10, slot, handle [,entry offset [,VR index]])

DESCRIPTION:

Returns the error log entry. If no entry offset is supplied, then the last entry (offset = 0) is returned. Otherwise, 1 will return the previous entry, 2 will return the last one but 2 etc.

PARAMETERS:

value:	**TRUE**	the command was successful
	FALSE	the command was unsuccessful
slot:	Module slot in which the communication port is fitted	
handle:	Handle of the connection whose error log entry is required. If -1 then access general protocol errors (for example failed to open connection.)	
entry offset:	Entry in the error log. If not supplied then entry 0 is returned.	
VR index:	VR number which will hold the returned value. If set to -1 or not included, then the value is printed to the command-line terminal.	

EXAMPLE:

EXAMPLE 1

```
    'Get error log entries 0 to 4 and put in VR(100) to VR(104)
    FOR i=0 to 4
      error_flag = MODBUS($10, -1, modbus_handle, i, 100+i)
      IF error_flag = FALSE THEN
        PRINT "Error fetching error log entry ";i[0]
      ENDIF
    NEXT i
```

EXAMPLE 2

```
    'Get an error log entry from the terminal
    >>MODBUS($10, -1, modbus_handle, 0, -1)
    19
```

FUNCTION = $11:

SYNTAX:
MODBUS($11, slot, handle [,vr_index])

DESCRIPTION:
Return the count of the number of error codes logged for the given handle.

PARAMETERS:

value:	**TRUE**	the command was successful
	FALSE	the command was unsuccessful
slot:	Module slot in which the communication port is fitted	
handle:	Handle of the connection whose error log entry is required. If -1 then access general protocol errors (for example failed to open connection.)	
VR index:	VR number which will hold the returned value. If set to -1 or not included, then the value is printed to the command-line terminal.	

MODULE_IO_MODE

TYPE:
System Parameter (**MC_CONFIG** / **FLASH**)

DESCRIPTION:
This parameter sets the start address of any expansion module I/O channels. You can also turn off module I/O for backwards compatibility.

Note that extended IO mapping functionality is available using **MC_CONFIG** parameters **CANIO_BASE**, **DRIVEIO_BASE**, **MODULEIO_BASE** and **NODE_IO**. These replace the need to use **MODULE_IO_MODE** and provide control over exactly where IO points are positioned within the Controller IO map. However, if **MODULE_IO_MODE** is set to 2 then this takes precedence over the positioning of **CANIO** and **MODULE** IO via **CANIO_BASE** and **MODULEIO_BASE**.

This parameter is stored in Flash EPROM and can be included in the MC_**CONFIG** script.

VALUE:

0	Module I/O disabled

1	Module I/O is after controller I/O and before CAN I/O (default)
2	Module I/O is at the end of the I/O sequence
3	Module I/O disabled and CAN I/O starts at 32

If you are upgrading the firmware in an existing controller, this parameter may be set to 0. The default of 1 is on a factory installed system.

EXAMPLE:

A system with MC464, a Panasonic module (slot 0), a FlexAxis (slot 1) and a **CANIO** Module will have the following I/O assignment:

MODULE_IO_MODE=1 (default) + **DRIVEIO_BASE**=-1 + **CANIO_BASE**=0 + **MODULEIO_BASE**=0

0-7	Built in inputs
8-15	Built in bi-directional I/O
16-23	Panasonic inputs
24-27	FlexAxis inputs
28-31	FlexAxis bi-directional I/O
32-47	**CANIO** bi-directional I/O
48-1023	Virtual I/O

MODULE_IO_MODE=0 (off) + **DRIVEIO_BASE**=-1 + **CANIO_BASE**=0 + **MODULEIO_BASE**=0

0-7	Built in inputs
8-15	Built in bi-directional I/O
16-31	**CANIO** bi-directional I/O
32-1023	Virtual I/O

MODULE_IO_MODE=2 (end)

0-7	Built in inputs
8-15	Built in bi-directional I/O
16-31	**CANIO** bi-directional I/O

32-39	Panasonic inputs
40-43	FlexAxis inputs
44-47	FlexAxis bi-directional I/O
48-1023	Virtual I/O

SEE ALSO:

CANIO_BASE, DRIVEIO_BASE, MODULEIO_BASE, NODE_IO

MODULEIO_BASE

TYPE:

System Parameter (**MC_CONFIG**)

DESCRIPTION:

This parameter sets the start address of any expansion module I/O channels. Together with **CANIO_BASE**, **DRIVEIO_BASE** and **NODE_IO** the I/O allocation scheme can replace and expand the behaviour of **MODULE_IO_MODE**, however **MODULE_IO_MODE** takes precedence if its value has been changed to 2 (**CANIO** followed by **MODULE** IO).

VALUE:

-1	Module I/O disabled
0	Module I/O allocated automatically (default)
>= 8	Module I/O is located at this IO point address, truncated to the nearest multiple of 8

EXAMPLE:

A system with MC464, a Panasonic module (slot 0) and a **CANIO** Module will have the following I/O assignment:

MODULEIO_BASE=0 + **DRIVEIO_BASE**=0 + **CANIO_BASE**=0

0-7	Built in inputs
8-15	Built in bi-directional I/O
16-23	Panasonic module inputs
24-39	**CANIO** bi-directional I/O
40-47	Panasonic drive inputs
48-1023	Virtual I/O

MODULEIO_BASE=-1 + **DRIVEIO_BASE**=0 + **CANIO_BASE**=0

0-7	Built in inputs
8-15	Built in bi-directional I/O
16-31	**CANIO** bi-directional I/O
32-39	Panasonic drive inputs
40-1023	Virtual I/O

MODULEIO_BASE=200 + **DRIVEIO_BASE**=0 + **CANIO_BASE**=0

0-7	Built in inputs
8-15	Built in bi-directional I/O
16-31	**CANIO** bi-directional I/O
32-39	Panasonic drive inputs
40-199	Virtual I/O
200-207	Panasonic module inputs
208-1023	Virtual I/O

SEE ALSO:
CANIO_BASE, DRIVEIO_BASE, NODE_IO, MODULE_IO_MODE

MOTION_ERROR

TYPE:
System Parameter (read only)

DESCRIPTION:
The **MOTION_ERROR** provides a simple single indicator that at least one axis is in error and can indicate multiple axes that have an error.

VALUE:
A sum of the bits representing each axis that is in error.

Bit	Value	Axis
0	1	0
1	2	1
2	4	2
3	8	3
…		

EXAMPLE:

MOTION_ERROR=11 and **ERROR_AXIS**=3 indicates axes 0, 1 and 3 have an error and the axis 3 occurred first.

SEE ALSO:

AXISSTATUS, ERROR_AXIS

MOVE

TYPE:

Axis Command

SYNTAX:

MOVE(distance1 [,distance2 [,distance3 [,distance4...]]])

ALTERNATE FORMAT:

MO()

DESCRIPTION:

Incremental move. One axis or multiple axes move at the programmed speed and acceleration for a distance specified as an increment from the end of the last specified move. The first parameter in the list is sent to the **BASE** axis, the second to the next axis in the **BASE** array, and so on.

In the multi-axis form, the speed and acceleration employed for the movement are taken from the first axis in the **BASE** group. The speeds of each axis are controlled so as to make the resulting vector of the movement run at the **SPEED** setting.

Uninterpolated, unsynchronised multi-axis motion can be achieved by simply placing **MOVE** commands on each axis independently. If needed, the target axis for an individual **MOVE** can be specified using the **AXIS**() command modifier. This overrides the **BASE** axis setting for one **MOVE** only.

The distance values specified are scaled using the unit conversion factor axis parameter; **UNITS**. Therefore if, for example, an axis has 400 encoder edges/mm and **UNITS** for that axis are 400, the command **MOVE**(12.5) would move 12.5 mm. When **MERGE** is set to ON, individual moves in the same axis group are merged together to make a continuous path movement.

PARAMETERS:

distance1:	distance to move on base axis from current position.
distance2:	distance to move on next axis in **BASE** array from current position.
distance3:	distance to move on next axis in **BASE** array from current position.
distance4:	distance to move on next axis in **BASE** array from current position.

The maximum number of parameters is the number of axes available on the controller

EXAMPLES

EXAMPLE 1:

A system is working with a unit conversion factor of 1 and has a 1000 line encoder. Note that a 1000 line encoder gives 4000 edges/turn.

```
    MOVE(40000) ' move 10 turns on the motor.
```

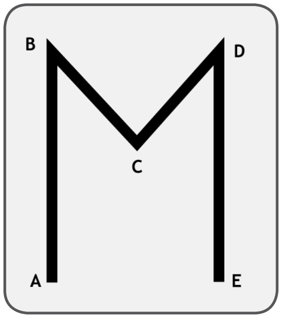
EXAMPLE 2:

Axes 3, 4 and 5 are to move independently (without interpolation). Each axis will move at its own programmed **SPEED**, **ACCEL** and **DECEL** etc.

```
    'setup axis speed and enable
    BASE(3)
    SPEED=5000
    ACCEL=100000
    DECEL=150000
    SERVO=ON
    BASE(4)
    SPEED=5000
    ACCEL=150000
    DECEL=560000
    SERVO=ON
    BASE(5)
    SPEED=2000
    ACCEL=320000
    DECEL=352000
    SERVO=ON
    WDOG=ON
    MOVE(10) AXIS(5)      'start moves
    MOVE(10) AXIS(4)
    MOVE(10) AXIS(3)
    WAIT IDLE AXIS(5)     'wait for moves to finish
    WAIT IDLE AXIS(4)
    WAIT IDLE AXIS(3)
```

EXAMPLE 3:

An X-Y plotter can write text at any position within its working envelope. Individual characters are defined as a sequence of moves relative to a start point so that the same commands may be used regardless of the plot origin. The command subroutine for the letter 'M' might be:



```
write_m:
  MOVE(0,12)  'move A >  B
  MOVE(3,-6)  'move B >  C
  MOVE(3,6)   'move C >  D
  MOVE(0,-12)'move D > E
  RETURN
```

MOVE_COUNT

TYPE:

Axis Parameter

DESCRIPTION:

MOVE_COUNT increments every time a motion command loads into the **MTYPE** buffer or when a command is automatically re-loaded such as **FLEXLINK**.

MOVE_COUNT can be written to set an initial value.

VALUE:

The number of movements loaded into the **MTYPE** buffer.

EXAMPLE:

Run the motion program and then turn on the OP(11) after 10 moves have been loaded.

```
MOVE_COUNT = 0
RUN "MOTION"
WAIT UNTIL MOVE_COUNT > 10
OP(11,ON)
```

MOVEABS

TYPE:

Axis Command.

SYNTAX:

MOVEABS(position1[, position2[, position3[, position4...]]])

ALTERNATE FORMAT:

MA()

DESCRIPTION:

Absolute position move. Move one axis or multiple axes to position(s) referenced with respect to the zero (home) position. The first parameter in the list is sent to the axis specified with the **AXIS** command or to the current **BASE** axis, the second to the next axis, and so on.

In the multi-axis form, the speed, acceleration and deceleration employed for the movement are taken from the first axis in the **BASE** group. The speeds of each axis are controlled so as to make the resulting vector of the movement run at the **SPEED** setting.

Uninterpolated, unsynchronised multi-axis motion can be achieved by simply placing **MOVEABS** commands on each axis independently. If needed, the target axis for an individual **MOVEABS** can be specified using the **AXIS**() command. This overrides the **BASE** axis setting for one **MOVEABS** only.

The values specified are scaled using the unit conversion factor axis parameter; **UNITS**. Therefore if, for example, an axis has 400 encoder edges/mm the **UNITS** for that axis is 400. The command **MOVEABS**(6) would then move to a position 6 mm from the zero position. When **MERGE** is set to ON, absolute and relative moves are merged together to make a continuous path movement.

The position of the axes' zero (home) positions can be changed by the commands: **OFFPOS**, **DEFPOS**, **REP_DIST**, **REP_OPTION**, and **DATUM**.

PARAMETERS:

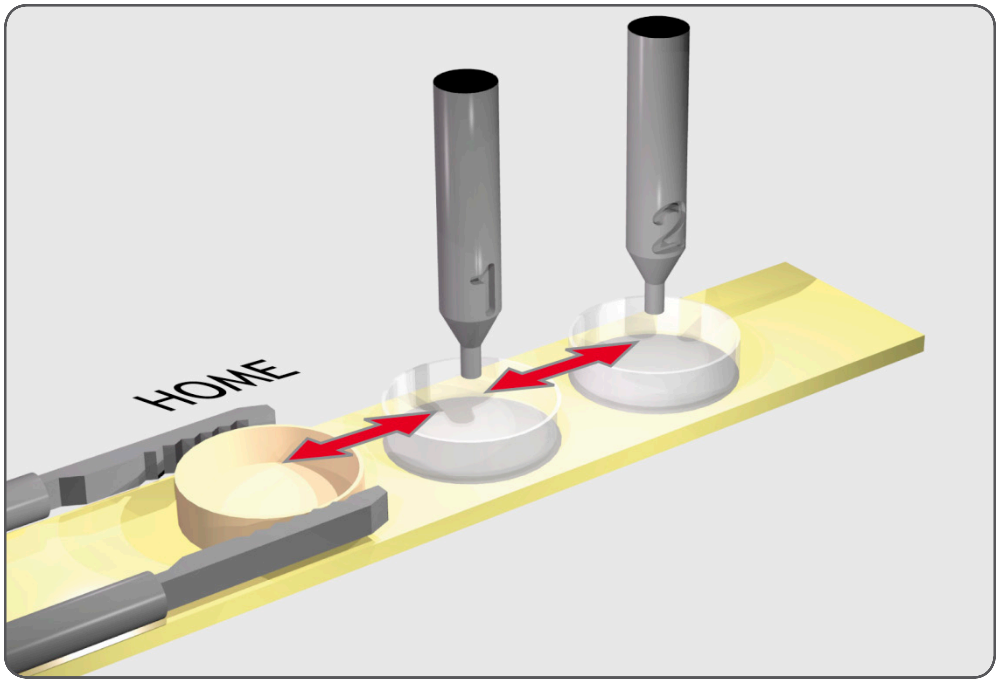
position1:	position to move to on base axis.
position2:	position to move to on next axis in **BASE** array.
position3:	position to move to on next axis in **BASE** array.
position4:	position to move to on next axis in **BASE** array

The **MOVEABS** command can interpolate up to the full number of axes available on the controller.

EXAMPLES:

EXAMPLE 1:

A machine must move to one of 3 positions depending on the selection made by 2 switches. The options are home, position 1 and position 2 where both switches are off, first switch on and second switch on respectively. Position 2 has priority over position 1.



```
 'define absolute positions
home=1000
position_1=2000
position_2=3000
WHILE IN(run_switch)=ON
  IF IN(6)=ON THEN        'switch 6 selects position 2
    MOVEABS(position_2)
    WAIT IDLE
  ELSEIF IN(7)=ON THEN    'switch 7 selects position 1
    MOVEABS(position_1)
    WAIT IDLE
  ELSE
    MOVEABS(home)
    WAIT IDLE
  ENDIF
WEND
```

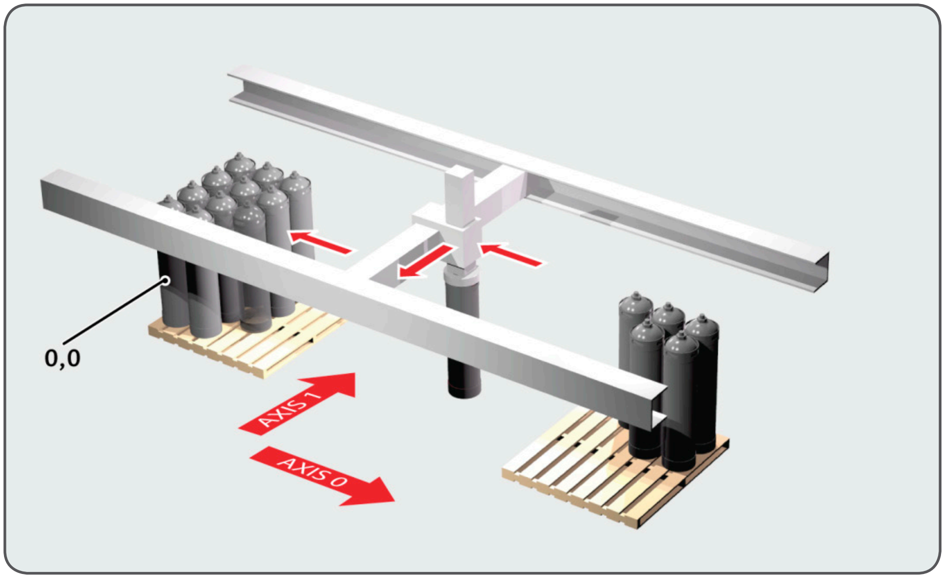
EXAMPLE 2:

An X-Y plotter has a pen carousel whose position is fixed relative to the plotter absolute zero position. To change pen an absolute move to the carousel position will find the target irrespective of the plot position when commanded.

```
    MOVEABS(28.5,350) 'move to just outside the pen holder area
    WAIT IDLE
    SPEED = pen_pickup_speed
    MOVEABS(20.5,350) 'move in to pick up the pen
```

EXAMPLE 3:

A pallet consists of a 6 by 8 grid in which gas canisters are inserted 185mm apart by a packaging machine. The canisters are picked up from a fixed point. The first position in the pallet is defined as position 0,0 using the **DEFPOS**() command. The part of the program to position the canisters in the pallet is:



```
    FOR x=0 TO 5
      FOR y=0 TO 7
        MOVEABS(-340,-516.5)      'move to pick-up point
        WAIT IDLE
        GOSUB pick                'call pick up subroutine
        PRINT "Move to Position: ";x*6+y+1
        MOVEABS(x*185,y*185)      'move to position in grid
        WAIT IDLE
        GOSUB place               'call place down subroutine
      NEXT y
    NEXT x
```

EXAMPLE 4:

Using **MOVEABS** with **REP_DIST** to move to a final position.

```
    REPDIST = 360
    DEFPOS(0)
    MOVEABS(300)   'will move through 300d egrees to 300
    MOVEABS(200)   'will move back 100 degrees to 200
    MOVEABS(370)   'will move through 170 degrees to 10 crossing repdist
    MOVEABS(350)   'will move through 340 degrees to 350
```

if you want to move in the shortest direction to the absolute position use **MOVETANG**

SEE ALSO:

MOVETANG

MOVEABSSEQ

TYPE:

Axis Command

SYNTAX:

`MOVEABSSEQ(table pointer, axes, npoints, options, radius)`

DESCRIPTION:

The **MOVEABSSEQ** command allows a sequence of 2 or 3 axis movements to be loaded via **TABLE** values. The moves can be automatically merged together using a circular or spherical arc.

The **MOVEABSSEQ** is loaded into the controller move buffers as a sequence of **MOVEABS**->**MOVECIRC**-> moves if 2 axes are specified and **MOVEABS**->**MSPHERICAL**-> if 3 axes are specified. The linear move may be omitted if the arcs blend together. If "Options" is set to 1 the move sequence loaded will be a sequence of **MOVEABSSP**->**MOVECIRCSP**-> moves if 2 axes are specified and **MOVEABSSP**->**MSPHERICALSP**-> if 3 axes are specified.

MOVE_COUNT is incremented on every move loaded.

The fillet Radius will automatically be reduced to the maximum possible if the points specified are insufficiently far apart to apply the fillet.

The current axes positions at the start of the **MOVEABSSEQ** are used for calculating the first fillet.

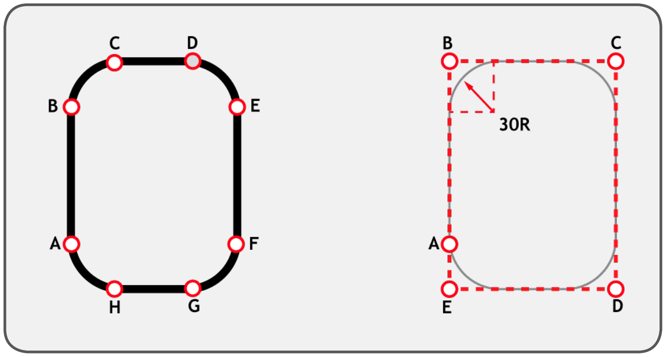
PARAMETERS:

Table pointer:	Location of the absolute points in **TABLE** memory.
Axes:	Number of axes 2 or 3.

Npoints:	The number of points, each point requires 2 or 3 table values.
Options	0 sets to load **MOVEABS** etc, 1 set to load embedded speed moves **MOVEABSSP** etc.
Radius	The merging/filleting radius to be applied. 0 for no filleting.

EXAMPLE:

Draw O using separate **MOVE** and **MOVECIRC**(see Trio Manual **MOVECIRC**), and draw similar O using **MOVEABSSEQ**.



```
 'MOVE and MOVECIRC:
MOVE(0,60) ' move A -> B
MOVECIRC(30,30,30,0,1) ' move B -> C
MOVE(20,0) ' move C -> D
MOVECIRC(30,-30,0,-30,1)' move D -> E
MOVE(0,-60) ' move E -> F
MOVECIRC(-30,-30,-30,0,1)' move F -> G
MOVE(-20,0) ' move G -> H
MOVECIRC(-30,30,0,30,1) ' move H -> A
WAIT IDLE
DEFPOS(100,30)
WAIT UNTIL OFFPOS=0

 ' MOVEABSSEQ:
TABLE(1000,100,120)
TABLE(1002,180,120)
TABLE(1004,180,0)
TABLE(1006,100,0)
TABLE(1008,100,30)

MOVEABSSEQ(1000,2,5,0,30)
```

MOVEABSSP

TYPE:
Axis Command.

SYNTAX:
MOVEABSSP(position1[, position2[, position3[, position4…]]])

DESCRIPTION:
Works as **MOVEABS** and additionally allows vector speed to be changed when using multiple moves in the look ahead buffer when **MERGE**=ON, using additional parameters **FORCE_SPEED**, **ENDMOVE_SPEED** and **STARTMOVE_SPEED**.

Absolute moves are converted to incremental moves as they enter the buffer. This is essential as the vector length is required to calculate the start of deceleration. It should be noted that if any move in the buffer is cancelled by the programmer, the absolute position will not be achieved.

PARAMETERS:

position1:	position to move to on base axis.
position2:	position to move to on next axis in **BASE** array.
position3:	position to move to on next axis in **BASE** array.
position4:	position to move to on next axis in **BASE** array

The maximum number of parameters is the number of axes available on the controller.

EXAMPLE:
In a series of buffered moves with **MERGE**=ON, an absolute move is required where the incoming vector speed is 40units/second and the finishing vector speed is 20 units/second.

```
FORCE_SPEED=40
ENDMOVE_SPEED=20
MOVEABSSP(100,100)
```

SEE ALSO:
MOVEABS

MOVECIRC

TYPE:
Axis Command.

SYNTAX:
`MOVECIRC(end1, end2, centre1, centre2, direction)`

ALTERNATE FORMAT:
`MC()`

DESCRIPTION:
Moves 2 orthogonal axes in such a way as to produce a circular arc at the tool point. The length and radius of the arc are defined by the five parameters in the command line. The move parameters are always relative to the end of the last specified move. This is the start position on the circle circumference. Axis 1 is the current **BASE** axis. Axis 2 is the next axis in the **BASE** array. The first 4 distance parameters are scaled according to the current unit conversion factor for the **BASE** axis.

In order for the **MOVECIRC**() command to be correctly executed, the two axes generating the circular arc must have the same number of encoder pulses/linear axis distance. If this is not the case it is possible to adjust the encoder scales in many cases by using **ENCODER_RATIO** or **STEP_RATIO**.

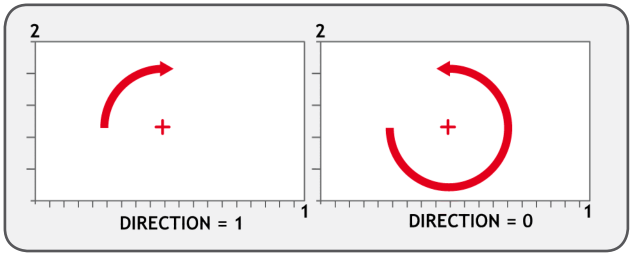
If the end point specified is not on the circular arc. The arc will end at the angle specified by a line between the centre and the end point.

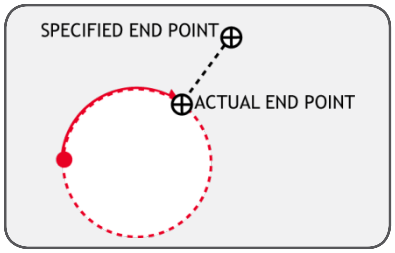
Neither axis may cross the set absolute repeat distance (**REP_DIST**) during a **MOVECIRC**. Doing so may cause one or both axes to jump or for their **FE** value to exceed **FE_LIMIT**.

PARAMETERS:

end1:	Position on **BASE** axis to finish at.
end2:	Position on next axis in **BASE** array to finish at.
centre1:	Position on **BASE** about which to move.
centre2:	Position on next axis in **BASE** array about which to move.

direction:	0	Arc is interpolated in an anti-clockwise direction
	1	Arc is interpolated in a clockwise direction
	2	Arc is interpolated using the shortest path to endpoint
	3	Arc is interpolated using the longest path to endpoint



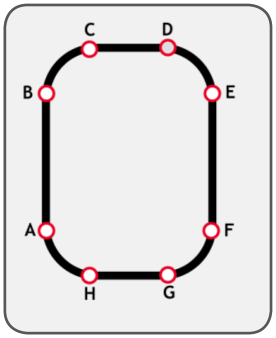


EXAMPLES:

EXAMPLE 1:

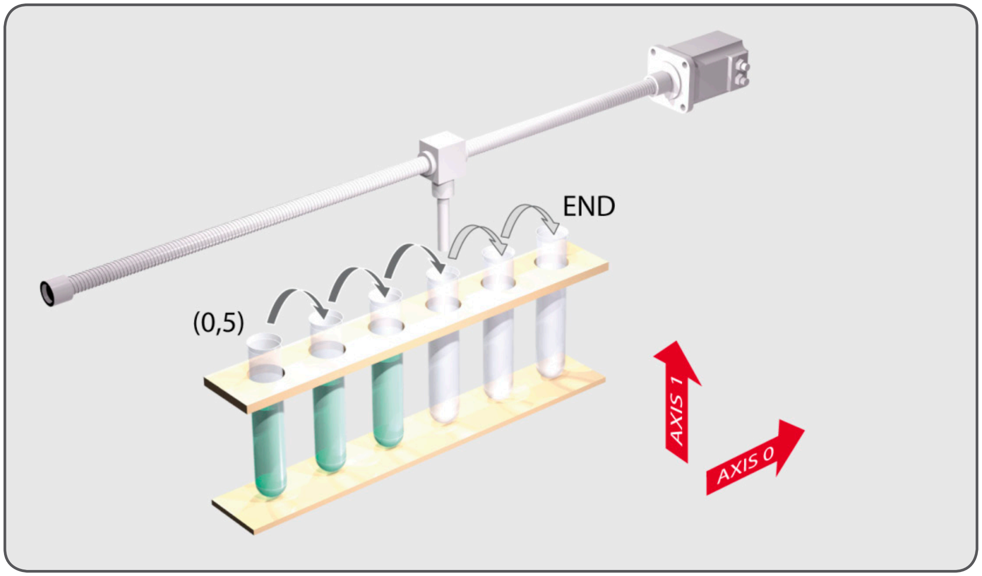
The command sequence to plot the letter ‘0’ might be:

```
    MOVE(0,6)                'move A -> B
    MOVECIRC(3,3,3,0,1)      'move B -> C
    MOVE(2,0)                'move C -> D
    MOVECIRC(3,-3,0,-3,1)    'move D -> E
    MOVE(0,-6)               'move E -> F
    MOVECIRC(-3,-3,-3,0,1)'move F -> G
    MOVE(-2,0)               'move G -> H
    MOVECIRC(-3,3,0,3,1)     'move H -> A
```



EXAMPLE 2:

A machine is required to drop chemicals into test tubes. The nozzle can move up and down as well as along its rail. The most efficient motion is for the nozzle to move in an arc between the test tubes.



```
BASE(0,1)
MOVEABS(0,5)                'move to position above first tube
MOVEABS(0,0)                'lower for first drop
WAIT IDLE
OP(15,ON)                   'apply dropper
WA(20)
OP(15,OFF)
```

```
    FOR x=0 TO 5
      MOVECIRC(5,0,2.5,0,1)   `arc between the test tubes
      WAIT IDLE
      OP(15,ON)               `Apply dropper
      WA(20)
      OP(15,OFF)
    NEXT x
    MOVECIRC(5,5,5,0,1)       `move to rest position
```

MOVECIRCSP

TYPE:

Axis Command.

SYNTAX:

MOVECIRCSP(end1, end2, centre1, centre2, direction)

DESCRIPTION:

Works as **MOVECIRC** and additionally allows vector speed to be changed when using multiple moves in the look ahead buffer when **MERGE**=ON, using additional parameters **FORCE_SPEED** and **ENDMOVE_SPEED**.

EXAMPLE:

In a series of buffered moves using the look ahead buffer with **MERGE**=ON, a circular move is required where the incoming vector speed is 40units/second and the finishing vector speed is 20 units/second.

```
    FORCE_SPEED=40
    ENDMOVE_SPEED=20
    MOVECIRCSP(100,100,0,100,1)
```

SEE ALSO:

MOVECIRC

MOVELINK

TYPE:

Axis Command.

SYNTAX:

MOVELINK (distance, link dist, link acc, link dec, link axis[, link options][, link pos]).

ALTERNATE FORMAT:

`ML()`

DESCRIPTION:

The linked move command is designed for controlling movements such as:

- Synchronization to conveyors
- Flying shears
- Thread chasing, tapping etc.
- Coil winding

The motion consists of a linear movement with separately variable acceleration and deceleration phases linked via a software gearbox to the **`MEASURED`** position (**`MPOS`**) of another axis. The command uses the **`BASE`**() and **`AXIS`**(), and unit conversion factors in a similar way to other move commands.

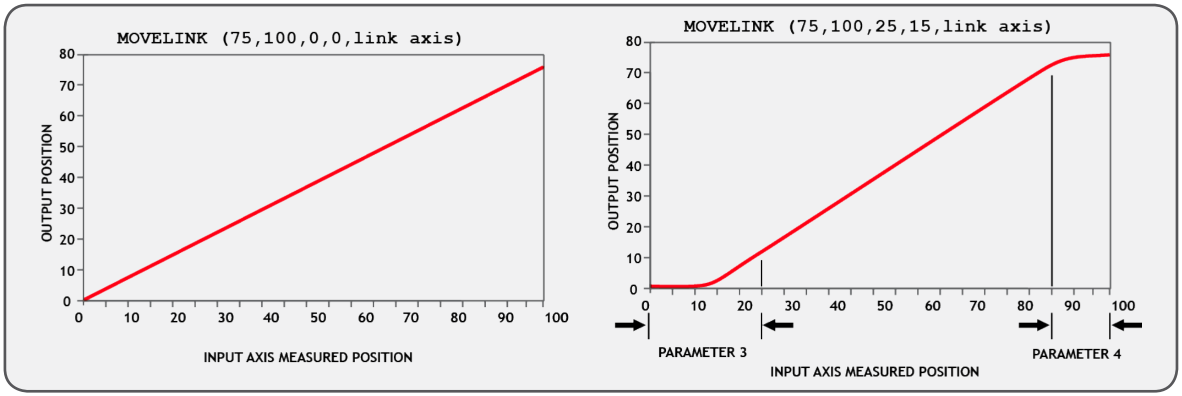
The “link” axis may move in either direction to drive the output motion. The link distances specified are always positive.

PARAMETERS:

distance:	incremental distance in user units to be moved on the current base axis, as a result of the measured movement on the “input” axis which drives the move.
link dist:	positive incremental distance in user units which is required to be measured on the “link” axis to result in the motion on the base axis.
link acc:	positive incremental distance in user units on the input axis over which the base axis accelerates.
link dec:	positive incremental distance in user units on the input axis over which the base axis decelerates.
link axis:	Specifies the axis to “link” to. It should be set to a value between 0 and the number of available axes.

link_options:	Bit value options to customize how your **MOVELINK** operates		
	Bit 0	1	link commences exactly when registration event **MARK** occurs on link axis
	Bit 1	2	link commences at an absolute position on link axis (see link_pos for start position)
	Bit 2	4	**MOVELINK** repeats automatically and bi-directionally when this bit is set. (This mode can be cleared by setting bit 1 of the **REP_OPTION** axis parameter)
	Bit 4	16	If this bit is set the **MOVELINK** acceleration and deceleration phases are constructed using an "S" speed profile not a trapezoidal speed profile
	Bit 5	32	Link is only active during a positive move on the link axis
	Bit 8	256	link commences exactly when registration event **MARKB** occurs on link axis
	Bit 9	512	link commences exactly when registration event **R_MARK** occurs on link axis. (see link_pos for channel number)
link_pos:	link_option bit 1 - the absolute position on the link axis in user **UNITS** where the **CAMBOX** is to be start. link_option bit 9 – the registration channel to start the movement on		

If the sum of parameter 3 and parameter 4 is greater than parameter 2, they are both reduced in proportion until they equal parameter 2.



The link_dist is in the user units of the link axis and should always be specified as a positive distance.

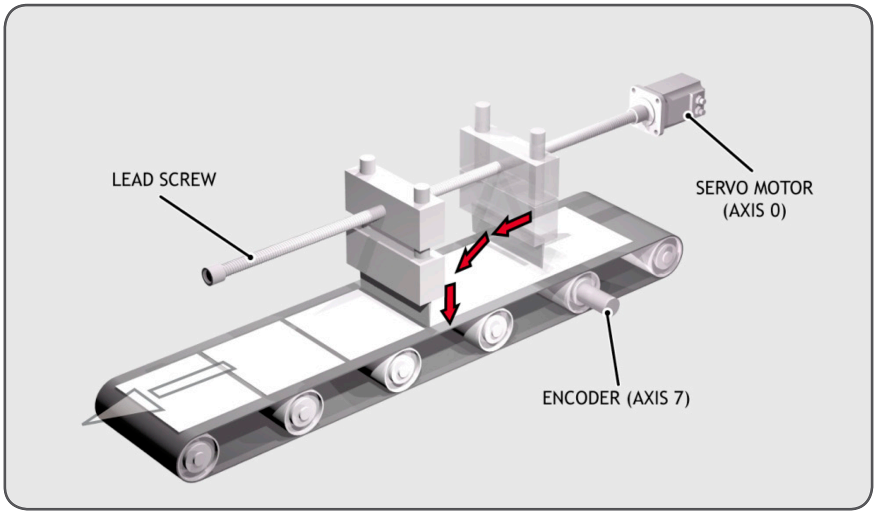
The link options for start (bits 1, 2, 8 and 9) may be combined with the link options for repeat (bits 4 and 8) and direction.

start_pos cannot be at or within one servo period's worth of movement of the **REP_DIST** position.

EXAMPLES:

EXAMPLE 1:

A flying shear cuts a long sheet of paper into cards every 160 m whilst moving at the speed of the material. The shear is able to travel up to 1.2 metres of which 1m is used in this example. The paper distance is measured by an encoder, the unit conversion factor being set to give units of metres on both axes: (Note that axis 7 is the link axis)



```
WHILE IN(2)=ON
  MOVELINK(0,150,0,0,7)      'dwell (no movement) for 150m
  MOVELINK(0.3,0.6,0.6,0,7)  'accelerate to paper speed
  MOVELINK(0.7,1.0,0,0.6,7)  'track the paper then decelerate
  WAIT LOADED  'wait until acceleration movelink is finished
  OP(8,ON)     'activate cutter
  MOVELINK(-1.0,8.4,0.5,0.5,7)  'retract cutter back to start
  WAIT LOADED
  OP(8,OFF)    'deactivate cutter at end of outward stroke
WEND
```

In this program the controller firstly waits for the roll to feed out 150m in the first line. After this distance the shear accelerates up to match the speed of the paper, moves at the same speed then decelerates to a stop within the 1m stroke. This movement is specified using two separate **MOVELINK** commands. This allows the program to wait for the next move buffer to be clear, **NTYPE**=0, which indicates that the acceleration phase is complete. Note that the distances on the measurement axis (link distance in each **MOVELINK** command): 150, 0.8, 1.0 and 8.2 add up to 160m.

To ensure that speed and positions of the cutter and paper match during the cut process the parameters of the **MOVELINK** command must be correct: It is normally easiest to consider the acceleration, constant speed and deceleration phases separately then combine them as required:

RULE 1:

In an acceleration phase to a matching speed the link distance should be twice the movement distance. The acceleration phase could therefore be specified alone as:

```
    MOVELINK(0.3,0.6,0.6,0,1)' move is all accel
```

RULE 2:

In a constant speed phase with matching speed the two axes travel the same distance so distance to move should equal the link distance. The constant speed phase could therefore be specified as:

```
    MOVELINK(0.4,0.4,0,0,1)' all constant speed
```

The deceleration phase is set in this case to match the acceleration:

```
    MOVELINK(0.3,0.6,0,0.6,1)' all decel
```

The movements of each phase could now be added to give the total movement.

```
    MOVELINK(1,1.6,0.6,0.6,1)' Same as 3 moves above
```

But in the example above, the acceleration phase is kept separate:

```
    MOVELINK(0.3,0.6,0.6,0,1)
    MOVELINK(0.7,1.0,0,0.6,1)
```

This allows the output to be switched on at the end of the acceleration phase.

EXAMPLE 2:

EXACT RATIO GEARBOX

MOVELINK can be used to create an exact ratio gearbox between two axes. Suppose it is required to create gearbox link of 4000/3072. This ratio is inexact (1.30208333) and if entered into a **CONNECT** command the axes will slowly creep out of synchronisation. Setting the "link option" to 4 allows a continuously repeating **MOVELINK** to eliminate this problem:

```
    MOVELINK(4000,3072,0,0,linkaxis,4)
```

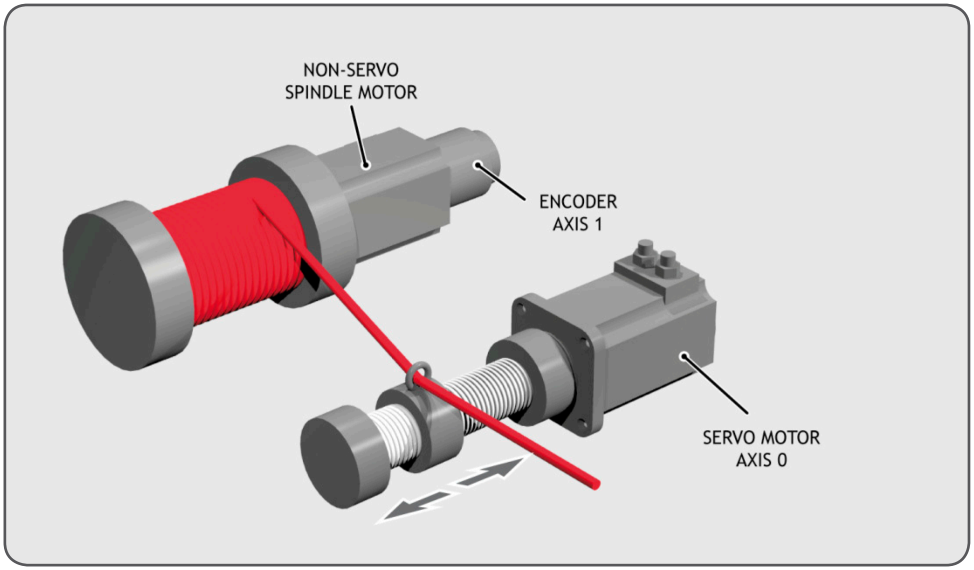
EXAMPLE 3:

COIL WINDING

In this example the unit conversion factors **UNITS** are set so that the payout movements are in mm and the spindle position is measured in revolutions. The payout eye therefore moves 50mm over 25 revolutions of the spindle with the command:

```
    MOVELINK(50,25,0,0,linkax).
```

If it were desired to accelerate up over the first spindle revolution and decelerate over the final 3 the command would be



```
MOVELINK(50,25,1,3,linkax)
OP(motor,ON)    '- Switch spindle motor on
FOR layer=1 TO 10
  MOVELINK(50,25,0,0,1)
  MOVELINK(-50,25,0,0,1)
NEXT layer
WAIT IDLE
OP(motor,OFF)
```

MOVEMODIFY

TYPE:
Axis Command.

SYNTAX:
`MOVEMODIFY(position)`

ALTERNATE FORMAT:
`MM()`

DESCRIPTION:

MOVEMODIFY will change the absolute end position of a single axis **MOVE**, **MOVEABS**, **MOVESP**, **MOVEABSSP** or **MOVEMODIFY** that is in the last position in the movement buffer. If there is no motion command in the movement buffers or the last movement is not a single axis linear move then **MOVEMODIFY** is loaded.

If the change in end position requires a change in direction the move in **MTYPE** is **CANCELed.** This will use **DECEL** unless **FASTDEC** has been specified.

If there are multiple buffered linier moves the **MOVEMODIFY** will only act on the command in front of it in the buffer.

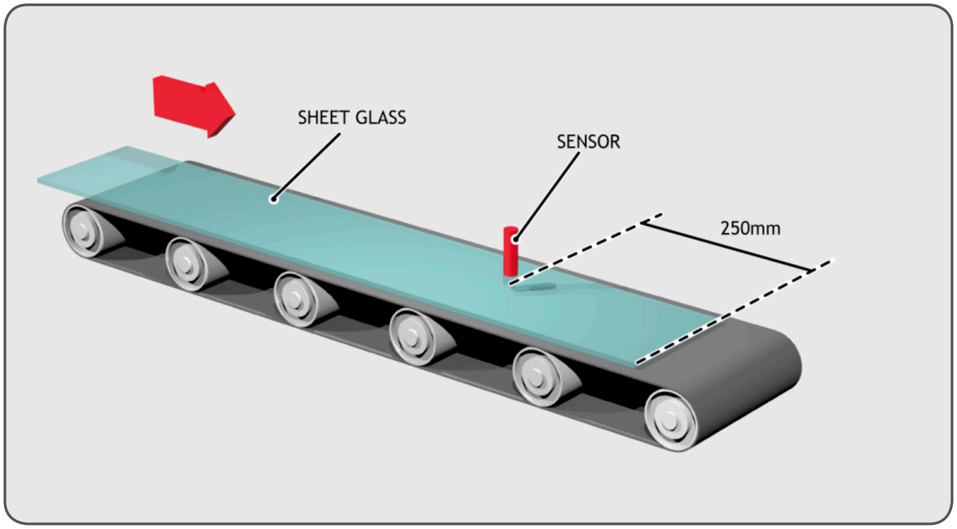
PARAMETERS:

position:	Absolute position for the current move to complete at.

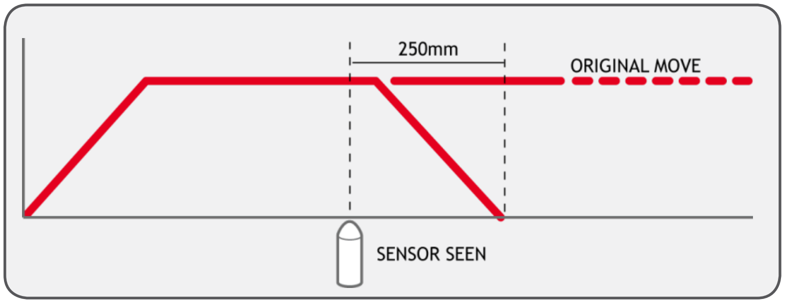
EXAMPLES:

EXAMPLE 1:

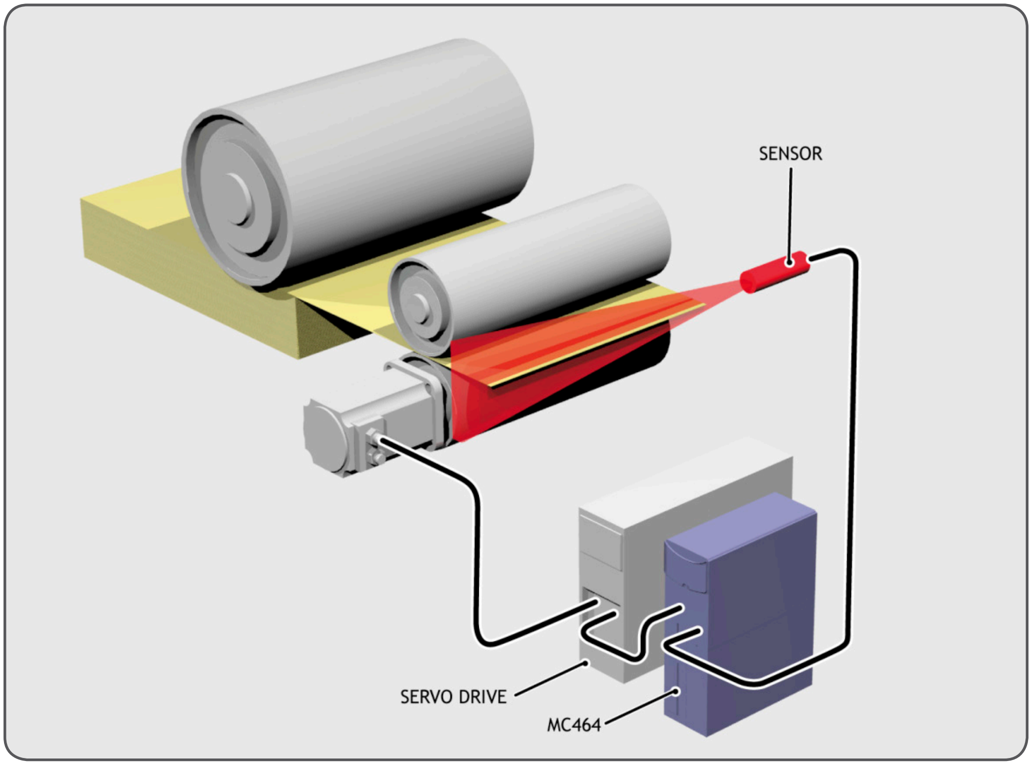
A sheet of glass is fed on a conveyor and is required to be stopped 250mm after the leading edge is sensed by a proximity switch. The proximity switch is connected to the registration input:



```
MOVE(10000)          'Start a long move on conveyor
REGIST(3)            'set up registration
WAIT UNTIL MARK      'MARK goes TRUE when sensor detects glass edge
OFFPOS = -REG_POS    'set position where mark was seen to 0
WAIT UNTIL OFFPOS=0  'wait for OFFPOS to take effect
MOVEMODIFY(250)      'change move to stop at 250mm
```



EAMPLE 2:
A paper feed system slips. To counteract this, a proximity sensor is positioned one third of the way into the movement. This detects at which position the paper passes and so how much slip has occurred. The move is then modified to account for this variation.

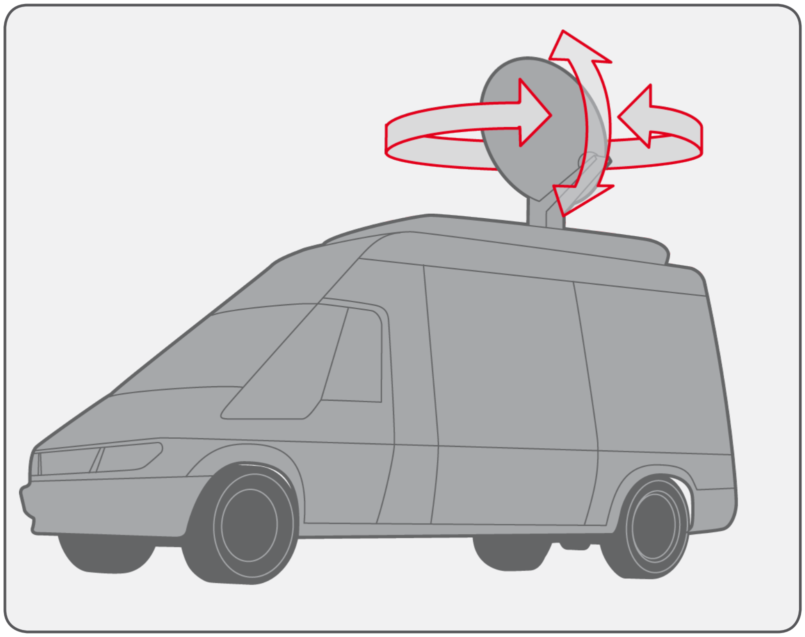


```
    paper_length=4000
```

```
DEFPOS(0)
REGIST(3)
MOVE(paper_length)
WAIT UNTIL MARK
slip=REG_POS-(paper_length/3)
offset=slip*3
MOVEMODIFY(paper_length+offset)
```

EXAMPLE 3:

A satellite receiver sits on top of a van; it has to align correctly to the satellite from data processed in a computer. This information is sent to the controller through the serial link and sets **VR**s 0 and 1. This information is used to control the two axes. **MOVEMODIFY** is used so that the position can be continuously changed even if the previous set position has not been achieved.



```
bearing=0           'set labels for VRs
elevation=1
UNITS AXIS(0)=360/counts_per_rev0
UNITS AXIS(1)=360/counts_per_rev1
WHILE IN(2)=ON
  MOVEMODIFY(VR(bearing))AXIS(0)    'adjust bearing to match VR0
  MOVEMODIFY(VR(elevation))AXIS(1)  'adjust elevation to match VR1
  WA(250)
WEND
```

```
    RAPIDSTOP              `stop movement
    WAIT IDLE AXIS(0)
    MOVEABS(0) AXIS(0)     `return to transport position
    WAIT IDLE AXIS(1)
    MOVEABS(0) AXIS (1)
```

SEE ALSO:

ENDMOVE

MOVES_BUFFERED

TYPE:

Axis Parameter (Read only)

DESCRIPTION:

This returns the number of moves being buffered by the axis.

The value does not include the move in the *MTYPE* buffer.

PARAMETERS:

value:	number of commands in the move buffers.

EXAMPLE:

Check if there is room in the move buffer before adding in another command.

```
    IF MOVES_BUFFERED < 64 THEN
      xpos = TABLE(count+x)
      ypos = TABLE(count+y)
      MOVEABS(xpos, ypos)
      count=count + 1
    ENDIF
```

MOVESEQ

TYPE:

Axis Command

SYNTAX:

MOVESEQ(table pointer, axes, npoints, options, radius)

DESCRIPTION:

The **MOVESEQ** command allows a sequence of 2 or 3 axis movements to be loaded via **TABLE** values. The moves can be automatically merged together using a circular or spherical arc.

The **MOVESEQ** is loaded into the controller move buffers as a sequence of **MOVE**->**MOVECIRC**-> moves if 2 axes are specified and **MOVE**->**MSPHERICAL**-> if 3 axes are specified. The linear move may be omitted if the arcs blend together. If "Options" is set to 1 the move sequence loaded will be a sequence of **MOVESP**->**MOVECIRCSP**-> moves if 2 axes are specified and **MOVESP**->**MSPHERICALSP**-> if 3 axes are specified.

MOVE_COUNT is incremented on every move loaded.

The fillet Radius will automatically be reduced to the maximum possible if the points specified are insufficiently far apart to apply the fillet.

The current axes positions at the start of the **MOVESEQ** are used for calculating the first fillet.

PARAMETERS:

Table pointer:	Location of the absolute points in **TABLE** memory.
Axes:	Number of axes 2 or 3.
Npoints:	The number of points, each point requires 2 or 3 table values.
Options	0 sets to load **MOVE** etc, 1 set to load embedded speed moves **MOVESP** etc.
Radius	The merging/filleting radius to be applied. 0 for no filleting.

EXAMPLE:

Draw a sequence of movements using **MOVESEQ**:

```
FOR x = 0 TO 2
    BASE(x)
    ATYPE = 0
    UNITS = 100
    ACCEL = 500
    DECEL = ACCEL
    SERVO = ON
    SPEED = 100
NEXT x

BASE(0,1,2)

DEFPOS(100,0,0)
WAIT UNTIL OFFPOS=0

TABLE(1000,-100,0,0)
TABLE(1003,0,200,0)
TABLE(1006,200,0,0)
TABLE(1009,0,200,0)
TABLE(1012,150,0,0)
TABLE(1015,-50,-400,0)
TABLE(1018,-300,-200,0)

TRIGGER
WA(10)

MOVESEQ(1000,3,7,1,300)
WAIT IDLE
```

MOVESP

TYPE:
Axis Command

SYNTAX:
MOVESP(distance1[,distance2[,distance3[,distance4…]]])

DESCRIPTION:
Works as **MOVE** and additionally allows vector speed to be changed when using multiple moves in the look ahead buffer when **MERGE**=ON, using additional parameters **FORCE_SPEED**, **ENDMOVE_SPEED** and **STARTMOVE_SPEED**.

PARAMETERS:

distance1:	distance to move on base axis from current position.
distance2:	distance to move on next axis in **BASE** array from current position.
distance3:	distance to move on next axis in **BASE** array from current position.
distance4:	distance to move on next axis in **BASE** array from current position.

The maximum number of parameters is the number of axes available on the controller

EXAMPLE:
In a series of buffered moves with **MERGE**=ON, an incremental move is required where the incoming vector speed is 40units/second and the finishing vector speed is 20 units/second.

```
FORCE_SPEED=40
ENDMOVE_SPEED=20
MOVESP(100,100)
```

SEE ALSO:
MOVE

MOVETANG

TYPE:
Axis Command

SYNTAX:
`MOVETANG(absolute_position, [link_axis])`

DESCRIPTION:
Moves the axis to the required position using the programmed **SPEED**, **ACCEL** and **DECEL** for the axis. The direction of movement is determined by a calculation of the shortest path to the position assuming that the axis is rotating and that **REP_DIST** has been set to PI radians (180 degrees) and that **REP_OPTION**=0.

The **REP_DIST** value will depend on the **UNITS** value and the number of steps representing **PI** radians. For example if the rotary axis has 4000 pulses/turn and **UNITS**=1 the **REP_DIST** value would be 2000.

MOVETANG does not get cleared from the **MTYPE** when it has completed its movement. This is so that you can use it in a tight loop which updates the end position by calling the **MOVETANG** again. When using the link_axis the end position is automatically updated from **TANG_DIRECTION** of the link axis.

PARAMETERS:

absolute_position:	The absolute position to be set as the endpoint of the move. Value must be within the range -PI to +PI in the units of the rotary axis. For example if the rotary axis has 4000 pulses/turn, the **UNITS** value=1 and the angle required is PI/2 (90 deg) the position value would be 1000.
link_axis	An optional link axis may be specified. When a link_axis is specified the system software calculates the absolute position required each servo cycle based on the link axis **TANG_DIRECTION**. The **TANG_DIRECTION** is multiplied by the **REP_DIST**/PI to calculate the required position. Note that when using a link_axis the absolute_ position parameter becomes unused. The position is copied every servo cycle until the **MOVETANG** is CANCELled.

EXAMPLES:

EXAMPLE 1:
An X-Y positioning system has a stylus which must be turned so that it is facing in the same direction as it is traveling at all times. A tangential control routine is run in a separate process.

```
BASE(0,1)
WHILE TRUE
  angle=TANG_DIRECTION
  MOVETANG(angle) AXIS(2)
WEND
```

EXAMPLE 2:

An X-Y positioning system has a stylus which must be turned so that it is facing in the same direction as it is traveling at all times.

The XY axis pair are axes 4 and 5. The tangential stylus axis is 2:

```
MOVETANG(0,4) AXIS(2)
```

EXAMPLE 3:

An X-Y cutting table has a “pizza wheel” cutter which must be steered so that it is always aligned with the direction of travel. The main X and Y axes are controlled by *Motion Coordinator* axes 0 and 1, and the pizza wheel is turned by axis 2.

Control of the Pizza Wheel is done in a separate program from the main X-Y motion program. In this example the steering program also does the axis initialisation.

PROGRAM TC_SETUP.BAS:

```
'Set up 3 axes for Tangential Control
WDOG=OFF

BASE(0)
P_GAIN=0.9
VFF_GAIN=12.85
UNITS=50  'set units for mm
SERVO=ON

BASE(1)
P_GAIN=0.9
VFF_GAIN=12.30
UNITS=50 'units must be the same for both axes
SERVO=ON

BASE(2)
UNITS=1  'make units 1 for the setting of rep_dist
REP_DIST=2000 'encoder has 4000 edges per rev.
REP_OPTION=0
UNITS=4000/(2*PI) 'set units for Radians
SERVO=ON

WDOG=ON
'Home the 3rd axis to its Z mark
DATUM(1) AXIS(2)
WAIT IDLE
WA(10)

'start the tangential control routine
BASE(0,1) 'define the pair of axes which are for X and Y
```

```
    `start the tangential control
    BASE(2)
    MOVETANG(0, 0) `use axes 0 and 1 as the linked pair
```

PROGRAM MOTION.BAS:

```
    `program to cut a square shape with rounded corners
    MERGE=ON
    SPEED=300

    nobuf=FALSE   `when true, the moves are not buffered
    size=120      `size of each side of the square
    c=30          `size (radius) of quarter circles on each corner

    DEFPOS(0,0)
    WAIT UNTIL OFFPOS=0
    WA(10)

    MOVEABS(10,10+c)
    REPEAT
      MOVE(0,size)
      MOVECIRC(c,c,c,0,1)
      IF nobuf THEN WAIT IDLE:WA(2)
      MOVE(size,0)
      MOVECIRC(c,-c,0,-c,1)
      IF nobuf THEN WAIT IDLE:WA(2)
      MOVE(0,-size)
      MOVECIRC(-c,-c,-c,0,1)
      IF nobuf THEN WAIT IDLE:WA(2)
      MOVE(-size,0)
      MOVECIRC(-c,c,0,c,1)
      IF nobuf THEN WAIT IDLE:WA(2)
    UNTIL FALSE
```

MPE

TYPE:
System Command

SYNTAX:
`MPE(mode)`

DESCRIPTION:

Sets the type of channel handshaking to be performed on the command line.

This is normally only used by the *Motion* Perfect program, but can be used for user applications with the PC*Motion* ActiveX control in asynchronous mode.

PARAMETERS:

mode:	0	No channel handshaking, XON/**XOFF** controlled by the port. When the current output channel is changed then nothing is sent to the command line. When there is not enough space to store any more characters in the current input channel then **XOFF** is sent even though there may be enough space in a different channel buffer to receive more characters
	1	Channel handshaking on, XON/**XOFF** controlled by the port. When the current output channel is changed, the channel change sequence is sent (<ESC><channel number>). When there is not enough space to store any more characters in the current input channel then **XOFF** is sent even though there may be enough space in a different channel buffer to receive more characters
	2	Channel handshaking on, XON/**XOFF** controller by the channel. When the current output channel is changed, the channel change sequence is sent (<ESC><channel number>). When there is not enough space to store any more characters in the current input buffer, then **XOFF** is sent for this channel (<**XOFF**><channel number>) and characters can still be received into a different channel.
	3	Channel handshaking on, XON/**XOFF** controller by the channel. In MPE(3) mode the system transmits and receives using a protected packet protocol using a 16 bit CRC.
	4	As mode 1 but with extra error reporting from the *Motion Coordinator*.

Whatever the **MPE** state, if a channel change sequence is received on the command line then the current input channel will be changed.

EXAMPLE:

Use the command line to demonstrate mode 0 and 1

```
>> PRINT #5,"Hello"
Hello
MPE(1)
>> PRINT #5,"Hello"
<ESC>5Hello
<ESC>0
>>
```

MPOS

TYPE:
Axis Parameter (Read Only)

DESCRIPTION:
This parameter is the position of the axis as measured by the encoder or resolver.

Unless using an absolute encoder **MPOS** is reset to 0 on power up or software reset.

The value is adjusted using the **DEFPOS**() command or **OFFPOS** axis parameter to shift the datum position or when the **REP_DIST** is in operation. The position is reported in user **UNITS**.

VALUE:
Actual axis position in user **UNITS**.

EXAMPLE:
```
    WAIT UNTIL MPOS>=1250
    SPEED=2.5
```

MSPEED

TYPE:
Axis Parameter (Read Only)

DESCRIPTION:
MSPEED can be used to represent the speed measured as it represents the change in measured position in user **UNITS** (per second) in the last servo period.

This value represents a snapshot of the speed and significant fluctuations can occur, particularly at low speeds. It can be worthwhile to average several readings if a stable value is required at low speeds.

VALUE:
Change in measured position per second in user **UNITS**.

EXAMPLE:
Average **MSPEED** using a filter algorithm.
```
    ` VR(10) filter output

    c = 0.005 `filter coefficient (0<c<1)
```

```
VR(10)=MSPEED  'initialise filter output to MSPEED

WHILE TRUE
  WA(1)
  VR(10)=(1-c)*VR(10)+c*MSPEED
WEND
```

MSPHERICAL

TYPE:
Axis Command

SYNTAX:
`MSPHERICAL({parameters}, mode [, gtpi][, rotau][, rotav][, rotaw])`

DESCRIPTION:
Moves the three axis group defined in **BASE** along a spherical path with a vector speed determined by the **SPEED** set in the first axis of the **BASE** array. There are 2 modes of operation with the option of finishing the move at an endpoint different to the start, or returning to the start point to complete a circle. The path of the movement in 3D space can be defined either by specifying a point somewhere along the path, or by specifying the centre of the sphere.

PARAMETERS:

mode:	0	specify end point and mid point on curve.
	1	specify end point and centre of sphere.
	2	two mid point are specified and the curve completes a full circle.
	3	mid point on curve and centre of sphere are specified and the curve completes a full circle.
gtpi:		If this optional parameter is non zero, modes 0 and 1 will perform a move taking the opposite way around a 360 degree circle to the same endpoint.
rotau:		If this optional parameter is non zero, a 4th axis will perform linear interpolation at the same time as the spherical move. The axis is the next in the **BASE** sequence. The move distance does not affect the path length or time taken for the movement. The path length is calculated just from the spherical distance.
rotav:		If this optional parameter is non zero, a 5th axis will perform linear interpolation at the same time as the spherical move.
rotaw:		If this optional parameter is non zero, a 6th axis will perform linear interpolation at the same time as the spherical move.

If you specify the parameters for the third axis as 0 and assign it to a virtual, you can use **MSPHERICAL** to perform circular movements. This allows you to specify the arc without knowing the centre point.

MODE = 0:

SYNTAX:

```
MSPHERICAL(endx, endy, endz, midx, midy, midz, 0)
```

DESCRIPTION:

Move the three axis, set in the **BASE** array through a section of a sphere by specifying the end point and a mid point on the curve.

PARAMETERS:

endx:	End position of the first axis
endy:	End position of the second axis
endz:	End position of the third axis
midx:	Mid position of the first axis
midy:	Mid position of the second axis
midz:	Mid position of the third axis

MODE = 1:

SYNTAX:

```
MSPHERICAL(endx, endy, endz, centrex, centrey, centrez, 1)
```

DESCRIPTION:

Move the three axis, set in the **BASE** array through a section of a sphere by specifying the end point and the centre of the sphere. The profile will always go the shortest path to the endpoint, this may be clockwise or counterclockwise.

The coordinates of the centre point and end point must not be co-linear. Semi-circles cannot be defined by using mode 1 because the sphere centre would be co-linear with the endpoint. If co-linier points are specified the controller will stop the program with a **RUN_ERROR**.

PARAMETERS:

endx:	End position of the first axis
endy:	End position of the second axis
endz:	End position of the third axis
centrex:	position of the first axis
centrey:	Centre position of the second axis
centrez:	Centre position of the third axis

MODE = 2:

SYNTAX:
`MSPHERICAL(midx1, midy1, midz1, midx, midy, midz, 2)`

DESCRIPTION:
Move the three axis, set in the **BASE** array through a full circle on a sphere by specifying two mid points of the curve. The profile will move through the first mid position, then the second and finally back to the start point.

PARAMETERS:

midx1:	Second mid position of the first axis
midy1:	Second mid position of the second axis
midz1:	Second mid position of the third axis
midx:	First mid position of the first axis
midy:	First mid position of the second axis
midz:	First mid position of the third axis

MODE = 3:

SYNTAX:
`MSPHERICAL(midx, midy, midz, centrex, centrey, centrez, 3)`

DESCRIPTION:

Move the three axis, set in the **BASE** array through a full circle on a sphere by specifying a mid point and the centre of the sphere. The profile will start by heading in the shortest distance to the mid point, this enables you to define the direction.

The coordinates of the centre point and mid point must not be co-linear. If co-linier points are specified the controller will stop the program with a **RUN_ERROR**.

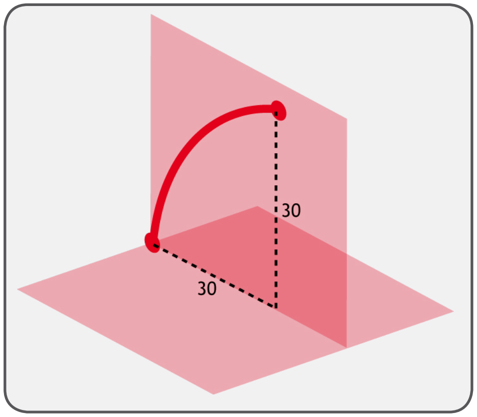
PARAMETERS:

midx:	Mid position of the first axis
midy:	Mid position of the second axis
midz:	Mid position of the third axis
centrex:	position of the first axis
centrey:	Centre position of the second axis
centrez:	Centre position of the third axis

EXAMPLES:

EXAMPLE 1:

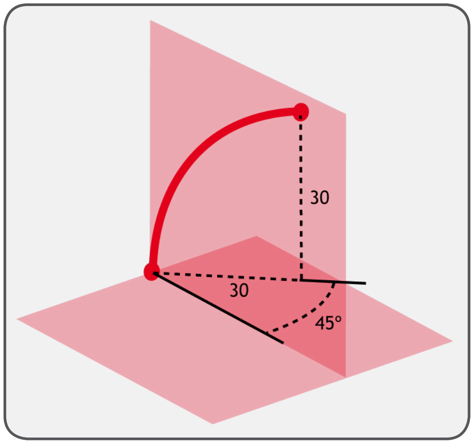
A move is needed that follows a spherical path which ends 30mm up in the Z direction:



```
    BASE(3,4,5)
    MSPHERICAL(30,0,30,8.7868,0,21.2132,0)
```

EXAMPLE 2:

A similar move that follows a spherical path but at 45 degrees to the Y axis which ends 30mm above the XY plane:



```
    BASE(0,1,2)
    MSPHERICAL(21.2132,21.2132,30,6.2132,6.2132,21.213
```

MSPHERICALSP

TYPE:

Axis Command

SYNTAX:

`MSPHERICAL({parameters}, mode [, gtpi][, rotau][, rotav][, rotaw])`

DESCRIPTION:

Performs a spherical move the same as **MSPHERICAL** and additionally allows vector speed to be changed when using multiple moves in the look ahead buffer when **MERGE**=ON, using additional parameters **FORCE_SPEED**, **ENDMOVE_SPEED** and **STARTMOVE_SPEED**

EXAMPLE:

A move is needed that follows a spherical path which ends 30mm up in the Z direction, the profile should decelerate from the previous move so that it is performed at 30UNITS/second:

```
    BASE(3,4,5)
    FORCE_SPEED=30
    ENDMOVE_SPEED=30
    MSPHERICALSP(30,0,30,8.7868,0,21.2132,0)
```

SEE ALSO:
MSPHERICAL

MTYPE

TYPE:
Axis Parameter (read only)

DESCRIPTION:
This parameter holds the type of move currently being executed.

This parameter may be interrogated to determine whether a move has finished or if a transition from one move type to another has taken place.

A non-idle move type does not necessarily mean that the axis is actually moving. It may be at zero speed part way along a move or interpolating with another axis without moving itself.

It takes a servo period before a motion command is loaded into the buffer, so checking **MTYPE** immediately after a motion command will probably fail. You should use **WAIT LOADED** or **WAIT IDLE** to check that a command is loaded or complete

VALUE:

Value	*Motion* command in progress
0	Idle (No move)
1	**MOVE**
2	**MOVEABS**
3	**MHELICAL**
4	**MOVECIRC**
5	**MOVEMODIFY**
6	**MOVESP**
7	**MOVEABSSP**
8	**MOVECIRCSP**
9	**MHELICALSP**
10	**FORWARD**

Value	*Motion* command in progress
11	**REVERSE**
12	**DATUM**
13	CAM
14	**FWD_JOG**
15	**REV_JOG**
20	**CAMBOX**
21	**CONNECT**
22	**MOVELINK**
23	**CONNPATH**
24	**FLEXLINK**
30	**MOVETANG**
31	**MSPHERICAL**

EXAMPLE:

Load another move if the existing move has finished

```
IF MTYPE AXIS(2) = 0 THEN
  MOVE (TABLE(count)) AXIS(2)
  count = count + 1
ENDIF
```

SEE ALSO:

WAIT

* Multiply

TYPE:

Mathematical operator

SYNTAX

<expression1> * <expression2>

DESCRIPTION:

Multiplies expression1 by expression2

PARAMETERS:

expression1:	Any valid TrioBASIC expression
expression2:	Any valid TrioBASIC expression

EXAMPLE:

Calculate the value of ‘factor’ by multiplying 10 by the sum of 2.1 and 9. the value stored in ‘factor’ will be 111.

```
    factor=10*(2.1+9)
```

N_ANA_IN

TYPE:
System Parameter (read only)

ALTERNATIVE FORMAT:
`NAIO`

DESCRIPTION:
This parameter returns the number of analogue input channels available to the *Motion Coordinator*. This includes all built in and external inputs.

VALUE:
The number of analogue inputs

EXAMPLE:
Check the system configuration in the command line for the correct number of analogue inputs.

```
>>PRINT N_ANA_IN
10
>>
```

N_ANA_OUT

TYPE:
System Parameter (Read Only)

DESCRIPTION:
This parameter returns the number of analogue output channels available to the controller

VALUE:
The number of analogue outputs

EXAMPLE:
Use the command line to check that the system has detected the correct number of analogue outputs:

```
>>PRINT N_ANA_OUT
12
>>
```

NEG_OFFSET

TYPE:
Axis Parameter

DESCRIPTION:
For Piezo Motor Control. This sets an offset to the DAC output when the position loop is demanding a negative voltage output. **NEG_OFFSET** is applied after **DAC_SCALE** so is always a value appropriate to the D to A converter resolution. The negative offset must be a negative value.

EXAMPLE:
An offset of -0.1 volts is required on an axis with a 16 bit D to A converter. With a 16 bit DAC, -10V is commanded with the value -32768 so for -0.1V need -32768 / 100.

```
NEG_OFFSET = -328
```

POS_OFFSET and **NEG_OFFSET** are normally used together. It is suggested that the offset is 65% to 70% of the value required to make the stage move in an open loop situation.

```
POS_OFFSET = 450
NEG_OFFSET = -395
```

NEW

TYPE:
System Command

SYNTAX:
NEW [item]

DESCRIPTION:
Deletes a program or table from the controller memory. If you are deleting a program from within a TrioBASIC program it is recommended to use the DEL command as makes easier to read code.

When deleting the table all the values are set to 0

Do not delete programs when connected to *Motion* Perfect as it will cause a controller mismatch and you will be disconnected.

PARAMETERS:

none	deletes the currently selected program	
item	"**TABLE**"	sets all table values to 0
	"name"	deletes a named program
	ALL	deletes all programs

Quotes (") are required when deleting the table or a named program.

EXAMPLE:

EXAMPLE1:
Delete a named program on the command line:

```
>>NEW "NAMEDPROGRAM"
OK
>>
```

EXAMPLE 2:
Clear all table values to 0

```
>>NEW "TABLE"
OK
>>
```

SEE ALSO:
DEL

NIN

TYPE:
System Parameter

DESCRIPTION:
This parameter returns the number of inputs fitted to the system. The value is normally set by the firmware taking into consideration the total IO detected; including module IO, CAN IO, Fieldbus IO and CanOpen IO.

VALUE:
The highest input point + 1 that is in use.

EXAMPLE:
There are 24 external Output points in addition to the 16 built-in IO points on the controller. Typing ?NIN in the terminal:

```
>>?NIN
40.0000
>>
```

Note; in this case the last input point addressable is IN(39).

NIO

TYPE:
System Parameter

DESCRIPTION:
This parameter returns the number of inputs/outputs fitted to the system. The value is normally set by the firmware taking into consideration the total IO detected; including module IO, CAN IO, Fieldbus IO and CanOpen IO.

Inputs / Outputs outside of **NIO** can be used as virtual

VALUE:
The highest input / output point + 1 that is in use. If the number of Inputs is not the same as the number of Outputs then the higher count is returned in the NIO parameter.

EXAMPLE:
There are 32 external IO points in addition to the 16 built-in IO points on the controller. Typing ?NIO in the terminal:

```
>>?NIO
48.0000
>>
```

Note; in this case the last IO point addressable is IN(47) and OP(47,state)

NODE_AXIS

TYPE:
System Array (**MC_CONFIG**)

SYNTAX:
`NODE_AXIS(slot, node)= value`

DESCRIPTION:
This 2D array can be used to over-ride the drive addressing of any EtherCAT node axis. This can be used to define a user specific axis map to fix axes from different sources in place.

The array is 2-dimensional, the first dimension is the master slot identifier, the second dimension is the position of the node within that master network.

An error is raised if the axis requested is already in use when the EtherCAT protocol is started.

VALUE:

0	EtherCAT axis is allocated automatically (default)
>= 1	EtherCAT drive is located at this axis

SEE ALSO:
`NODE_AXIS_COUNT, NODE_INDEX, NODE_PROFILE,`

NODE_AXIS_COUNT

TYPE:
System Array (**`MC_CONFIG`**)

SYNTAX:
`NODE_AXIS_COUNT(slot, node)= value`

DESCRIPTION:
This 2D array can be used to set the number of axes that are located at a single EtherCAT node. This can be used to define a user specific axis map when using multi-axis drives.

The array is 2-dimensional, the first dimension is the master slot identifier, the second dimension is the position of the node within that master network.

VALUE:

1	Single axis EtherCAT node (default)

2 - n	Number of axes allocated to the EtherCAT node

SEE ALSO:
NODE_AXIS, NODE_INDEX, NODE_PROFILE,

NODE_INDEX

TYPE:
System Array (**MC_CONFIG**)

SYNTAX:
NODE_INDEX(slot, node)= value

DESCRIPTION:
This 2D array can be used to set the pointer to a block of **VR**s used by the EtherCAT node. It can be used to define a user specific Input Output map from different data sources including Boolean and Integer data within the EtherCAT node.

There is one **VR** mapped per PDO object, starting with the values from slave to master, (eg slave actual values, DIN, status word, actual position etc.) then the values from master to slave (eg slave target values, **DOUT**, control word, target position etc.)

The array is 2-dimensional, the first dimension is the master slot identifier, the second dimension is the position of the node within that master network.

VALUE:

0 to 65535	EtherCAT cyclic data is mapped to a block of **VR**s starting at this **VR** index. (MC464)
0 to 4095	EtherCAT cyclic data is mapped to a block of **VR**s starting at this **VR** index. (MC4N)

SEE ALSO:
NODE_AXIS, NODE_AXIS_COUNT, NODE_PROFILE,

NODE_IO

TYPE:
System Parameter (**MC_CONFIG**)

DESCRIPTION:
This 2D array can be used to set the start address of any EtherCAT node I/O channels. This can be used to

define a user specific IO map to fix IO points from different sources in place.

The array is 2-dimensional, the first dimension is the master slot identifier, the second dimension is the position of the node within that master network.

VALUE:

0	EtherCAT I/O allocated automatically (default)
>= 8	EtherCAT I/O is located at this IO point address

EXAMPLE:

A system with MC464, an EtherCAT module (slot 0) and a **CANIO** Module will have the following I/O assignment:

MODULEIO_BASE=0 + **DRIVEIO_BASE**=0 + **CANIO_BASE**=0

0-7	Built in inputs
8-15	Built in bi-directional I/O
16-23	Panasonic module inputs
24-39	**CANIO** bi-directional I/O
40-47	Panasonic drive inputs
48-1023	Virtual I/O

MODULEIO_BASE=-1 + **DRIVEIO_BASE**=0 + **CANIO_BASE**=0

0-7	Built in inputs
8-15	Built in bi-directional I/O
16-31	**CANIO** bi-directional I/O
32-39	Panasonic drive inputs
40-1023	Virtual I/O

MODULEIO_BASE=200 + **DRIVEIO_BASE**=0 + **CANIO_BASE**=0

0-7	Built in inputs
8-15	Built in bi-directional I/O
16-31	**CANIO** bi-directional I/O
32-39	Panasonic drive inputs

40-199	Virtual I/O
200-207	Panasonic module inputs
208-1023	Virtual I/O

SEE ALSO:
`CANIO_BASE, MODULEIO_BASE, DRIVEIO_BASE, NODE_IO, MODULE_IO_MODE`

NODE_PROFILE

TYPE:
System Array (**`MC_CONFIG`**)

SYNTAX:
`NODE_PROFILE(slot, node)= value`

DESCRIPTION:
This 2D array is used to set the EtherCAT profile within the internal database to use the selected profile. Each profile gives extra functionality and is vendor and product code specific. Consult the extra technical notes made available for your connected slave device.

The array is 2-dimensional, the first dimension is the master slot identifier, the second dimension is the position of the node within that master network.

VALUE:

0	Use the default node profile / configuration (default)
>= 1	Use the specified EtherCAT profile / configuration

SEE ALSO:
`NODE_AXIS, NODE_INDEX, NODE_AXIS_COUNT,`

NOP

TYPE:
System Parameter

DESCRIPTION:

This parameter returns the number of outputs fitted to the system. The value is normally set by the firmware taking into consideration the total IO detected; including module IO, CAN IO, Fieldbus IO and CanOpen IO.

VALUE:

The highest output point + 1 that is in use.

EXAMPLE:

There are 64 external Output points in addition to the 8 built-in IO points on the controller. Typing ?NOP in the terminal:

```
>>?NOP
80.0000
>>
```

Note; in this case the last output point addressable is OP(79,state) and **READ_OP**(79). The outputs start at OP(8,state) so the NOP value is not the total output points, it is the number at which the output map has as the highest available.

NOT

TYPE:

Logical and Bitwise functions

SYNTAX:

```
NOT expression
```

DESCRIPTION:

The NOT function truncates the number and inverts all the bits of the integer remaining.

PARAMETER:

expression:	Any valid TrioBASIC expression.

EXAMPLES:

EXAMPLE 1:

Bitwise AND 7 with NOT 1.5. This truncates 1.5 to 1 then ANDs it with 7.

```
    PRINT 7 AND NOT(1.5)
      6.0000
```

EXAMPLE 2:

If a function fails then print an error message and stop the program

```
    IF NOT CAN(0,9,13,1,8,$6060,0,$02) THEN
      PRINT#user, “Failed to set velocity mode”
      STOP
    ENDIF
```

<> Not Equal

TYPE:

Comparison Operator

SYNTAX:

`<expression1> <> <expression2>`

DESCRIPTION:

Returns **TRUE** if expression1 is not equal to expression2, otherwise returns **FALSE**.

PARAMETERS:

Expression1:	Any valid TrioBASIC expression
Expression2:	Any valid TrioBASIC expression

EXAMPLE:

Run the Scoop subroutine if axis is not idle (**MTYPE**=0 indicates axis idle)

```
    IF MTYPE<>0 THEN GOTO scoop
```

NTYPE

TYPE:

Axis Parameter (Read Only)

DESCRIPTION:

This parameter holds the type of the first buffered move.

★ The **NTYPE** buffer can be cleared using **CANCEL**(1)

VALUE:

The numerical value of the move type

See **MTYPE** for a list of return values.

EXAMPLE:

If the first move buffer (**NTYPE**) is empty apply another move from a table

```
IF MTYPE = 0 THEN
  MOVE( TABLE(count)
  count = count +1
ENDIF
```

SEE ALSO:

MTYPE

OFF

TYPE:
Constant

DESCRIPTION:
OFF returns the value 0

EXAMPLES:

EXAMPLE 1:
Run the subroutine “tiger” if input 56 is off.

```
IF IN(56)=OFF THEN GOSUB tiger
```

EXAMPLE 2:
Turn the watchdog relay off

```
WDOG = OFF
```

OFFPOS

TYPE:
Axis Parameter

DESCRIPTION:
The **OFFPOS** parameter allows the axis position value to be offset by any amount without affecting the motion which is in progress. **OFFPOS** can therefore be used to effectively datum a system at full speed. Values loaded into the **OFFPOS** axis parameter are reset to 0 by the system software after the axis position is changed.

VALUE:
The distance to offset the current position

EXAMPLES:

EXAMPLE 1:
Change the current position by 125, using the command line terminal:

```
>>PRINT DPOS
300.0000
>>OFFPOS=125
>>PRINT DPOS
425.0000
```

```
>>
```

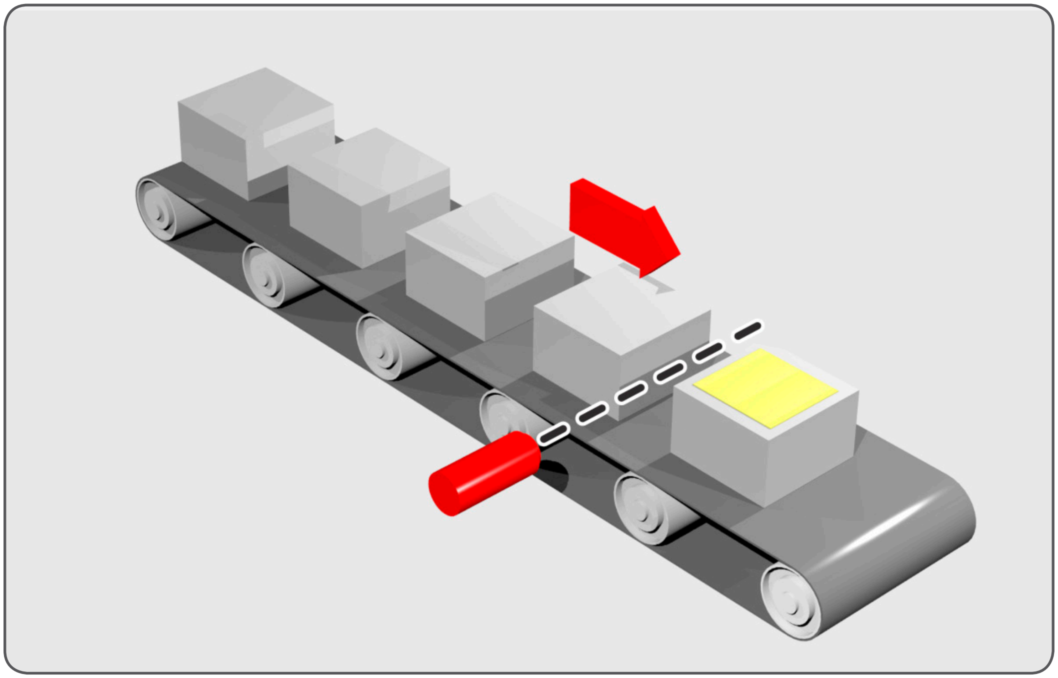
EXAMPLE 2:

Define the current demand position as zero:

```
    OFFPOS=-DPOS   'This is equivalent to DEFPOS(0)
```

EXAMPLE 3:

A conveyor is used to transport boxes onto which labels must be applied.



Using the **REGIST**() function, we can capture the position at which the leading edge of the box is seen, then by using **OFFPOS** we can adjust the measured position of the axis to be zero at that point. Therefore, after the registration event has occurred, the measured position (seen in **MPOS**) will actually reflect the absolute distance from the start of the box, the mechanism which applies the label can take advantage of the absolute position start mode of the **MOVELINK** or **CAMBOX** commands to apply the label.

```
    BASE(conv)
    REGIST(3)
    WAIT UNTIL MARK
    OFFPOS = -REG_POS ' Leading edge of box is now zero
```

ON

TYPE:
Constant

DESCRIPTION:
ON returns the value 1.

EXAMPLE:
This sets the output named lever to ON.

```
    OP(lever,ON)
```

ON.. GOSUB/ GOTO

TYPE:
Program Structure

SYNTAX:

```
ON expression GOxxx label[,label1[,...]]
…
label:
commands
RETURN
…
label1:
commands
RETURN
```

Where GOxxx can be **GOSUB** or **GOTO**

DESCRIPTION:
The expression is evaluated and then the integer part is used to select a label from the list. If the expression has the value 1 then the first label is used, 2 then the second label is used, and so on. Once a label is selected it is used with either **GOSUB** or **GOTO**

If the value of the expression is less than 1 or greater than the number of labels the command is stepped through with no action. Once the label is selected a *GOSUB* is performed.

PARAMETERS:

expression:	Any valid TrioBASIC expression, should return a value 1 or greater
commands:	TrioBASIC statements that you wish to execute
label:	A valid label that occurs in the program.
GOxxx	**GOSUB** or **GOTO**

If the label does not exist an error message will be displayed at run time and the program execution halted.

EXAMPLES:

EXAMPLE 1:

```
REPEAT
  GET #3,char
UNTIL 1<=char AND char<=3
ON char GOSUB mover,stopper,change
```

EXAMPLE 2:

Use inputs from a PLC to determine which program to run.

```
  ON (IN(4,6)+1)GOTO prog0, prog1, prog2, prog3, prog ` select program
  GOTO continue 'skip progs if unknown input selected
prog0:
  RUN "tuning",2
  GOTO continue
prog1:
  RUN "cutting",2
  GOTO continue
prog2:
  RUN "packing",2
  GOTO continue
prog3:
  RUN "moving",2
  GOTO continue
Prog4:
  RUN "lifting",2
  GOTO continue

continue:
  …
```

SEE ALSO:

GOSUB, GOTO,

OP

TYPE:
System Command

DESCRIPTION:
Sets output(s) and allows the state of the first 32 outputs to be read back.

There are four modes of operation for the OP command, using up to three parameters:

- Read Base Block
- Write Base Block
- Set Single Output
- Write Block

MODE = READ BASE BLOCK:

SYNTAX:
```
value = OP
```

DESCRIPTION:
Return the state of the first 32 outputs as a binary pattern.

PARAMETERS:

value	Binary pattern of the first 32 outputs

MODE = WRITE BASE BLOCK:

SYNTAX:
```
OP(state)
```

DESCRIPTION:
Simultaneously set the first 32 outputs with the binary pattern of the state.

PARAMETERS:

State	Decimal equivalent of binary number to set on outputs

MODE = SET SINGLE OUTPUT:

SYNTAX:
`OP(output, state)`

DESCRIPTION:
Set the state of an individual output

PARAMETERS:

output	Output number to set.
state	0 or OFF
	1 or ON

MODE = WRITE BLOCK:

SYNTAX:
`OP(start, end, state)`

DESCRIPTION:
Simultaneously set a defined group of outputs with the binary pattern of the state.

PARAMETERS:

start	First output in the group
end	Last output in the group
state	Decimal equivalent of binary number to set on the group

EXAMPLES:

EXAMPLE 1:
Turn on a single output 44

```
    OP(44,1)
```

This is equivalent to:

```
OP(44,ON)
```

EXAMPLE 2:

Sets the bit pattern 10010 on the first 5 physical outputs, outputs 13-31 will be cleared. Note how the bit pattern is shifted 8 bits by multiplying by 256 to set the first available outputs as 0 to 7 do not exist.

```
OP (18*256)
```

EXAMPLE 3:

Read the first 32 outputs, clear 0-7 as they are only inputs and 16-32. Then set 16-32 leaving 8-15 in their original state.

```
read_output:
  VR(0)=OP
  'clear 0-7 and 16-32
  VR(0)=VR(0) AND $0000FF00
  'set $1A42 in outputs 16-32,
  '8-15 will remain in their original state
  VR(0)=VR(0) OR $1A420000
  OP(VR(0))
```

EXAMPLE 4

Simultaneously setting outputs 10 to 13 all on.

```
OP(10,13, $F)
```

SEE ALSO:

READ_OP()

OPEN

TYPE:

Command

SYNTAX:

```
OPEN # channel AS "[location:]name" FOR access
```

DESCRIPTION:

OPEN will provide access to a text file on the controller. The text file can be initialised as a file that *Motion* Perfect can synchronise with, a temporary file, a file on the SD card or as a **FIFO** buffer. All files are in the controller file directory however only a text file can be viewed or edited in *Motion* Perfect.

Once the file has been opened then it can be manipulated by the standard TrioBASIC channel commands. If the file is opened with read access then any TrioBASIC **GET** type commands such as **GET**, **INPUT**, **LINPUT** and **KEY** can be used on the channel. If the file is opened with write access then the **PRINT** type commands can be used on the channel.

The channel should be closed using TrioBASIC command **CLOSE** when you have finished with it.

PARAMETERS:

channel:	The TrioBASIC # channel to be associated with the file. It is in the range 40 to 44.		
access:	The operations permitted on the file.		
	INPUT	The file will be opened for reading. When the end of the file is reached **KEY** will return **FALSE**, and the **GET** and **INPUT** functions will fail.	
	OUTPUT(mode)	The file will be opened for writing. If the file does not exist then it will be created. If the file does exist then it will be cleared.	
		mode	function
		0	Opens a text file that *Motion* Perfect can read, edit and save into the project.
		1	Opens a temporary file that is only accessible by the controller.
	FIFO_READ	The file will be opened for reading and will be managed as a circular buffer. This is only valid for files stored in internal RAM.	
	FIFO_WRITE(size)	The file will be opened for writing and will be managed as a circular buffer. This is only valid for files in internal RAM. If the file does not exist it will be created (size) bytes long. If the file does exist then it must be of type **FIFO**, the size parameter is ignored and the contents are cleared.	
name:	Name of the file to be opened. The format is "[RAM|SD:]filename". If the prefix is omitted or is RAM: then filename refers to an internal controller memory directory entry. If the prefix is SD: then filename refers to an **SDCARD** directory entry.		

If you are creating a file on the SD card you will need to append the file extension. A text file stored in controller memory will be saved as a .txt file in the project by *Motion* Perfect. This enables you to generate and read files on the SD card in any text based format.

If you are writing to a text file that *Motion* Perfect can read then be aware that *Motion* Perfect will not see the changes until you perform a Project Check. Be very careful when writing to a text file while connected to Motion perfect. If it is required to write to a file while connected to Motion perfect it is recommended to use the temp file, or one on the SD card.

EXAMPLES:

EXAMPLE 1:

Open a file that can be used to log information to a .txt file on the SD card then print end of shift information to the file.

```
OPEN#40 AS “SD:product_log.txt” FOR OUTPUT (0)
PRINT#40, DATE$ ‘Print the date
PRINT#40, products_complete[0]; “ products completed”
PRINT#40, product_failures[0]; “ products failed”
CLOSE#40
```

EXAMPLE 2:

A G-Code file is loaded from a serial port into the controller, it is saved into a temp file on the controller for use later on.

```
OPEN#41 AS “gcodeprogram” for OUTPUT (1)
WHILE file_downloading
  IF KEY#1
    GET#1, char
    PRINT#41, char;
  ENDIF
  Length=length + 1
WEND
CLOSE#41
```

EXAMPLE 3:

The G-Code program has been downloaded to a temp file, it then should be transferred to a **FIFO** so that it can be interpreted into motion.

```
OPEN#41 AS “gcodeprogram” for INPUT
OPEN#42 AS “gcodefifo” for FIFO_WRITE(length)
WHILE KEY#41
  GET#41, char
  PRINT#42, char;
WEND
CLOSE#42
CLOSE#41
```

SEE ALSO:

CLOSE, GET, INPUT, LINPUT, KEY

OPEN_WIN

TYPE:

Axis Parameter

ALTERNATE FORMAT:

OW

DESCRIPTION:

This parameter defines the first position of the window which will be used for registration marks if windowing is specified by the **REGIST**() command.

VALUE:

Absolute position of the first registration window

EXAMPLE:

Enable registration but only look for registration marks between 170 and 230mm

```
    OPEN_WIN=170.00
    CLOSE_WIN=230.0
    REGIST(256+3)
    WAIT UNTIL MARK
```

SEE ALSO:

CLOSE_WIN, REGIST

OR

TYPE:

Logical and Bitwise operator

SYNTAX:

<expression1> OR <expression2>

DESCRIPTION:

This performs an OR function between corresponding bits of the integer part of two valid TrioBASIC expressions.

The OR function between two bits is defined as follows:

OR	0	1
0	0	1
1	1	1

PARAMETERS:

expression1	Any valid Trio **BASIC** expression
expression2	Any valid Trio **BASIC** expression

EXAMPLES:

EXAMPLE 1:

Use OR to allow the program to progress if there is a **MOTION_ERROR** or an input is pressed

```
    WAIT UNTIL IN(2)=ON OR MOTION_ERROR
```

EXAMPLE 2:

Calculate the bitwise OR between values

```
    result=10 OR (2.1*9)
```

Trio **BASIC** evaluates the parentheses first giving the value 18.9, but as was specified earlier, only the integer part of the number is used for the operation, therefore this expression is equivalent to:

```
    result=10 OR 18
```

The OR is a bitwise operator and so the binary action taking place is:

```
         01010
    OR   10010
         11010
```

Therefore result holds the value 26

OUTDEVICE

TYPE:

Process Parameter

DESCRIPTION:

The value in this parameter determines the default active output device. Specifying an **OUTDEVICE** for a process allows the channel number to set for all subsequent **GET**, **KEY**, **INPUT** and **LINPUT** statements.

This command is process specific so other processes will use the default channel.

This command is available for backward compatibility, it is currently recommended to use #channel, instead.

VALUE:

The channel number to use for any inputs

For a full list of communication channels see #

EXAMPLE:

Set up a program to print all data to channel 5

```
    OUTDEVICE = 5

    IF error THEN
      PRINT "Error Detected"
    ENDIF
```

SEE ALSO:

#, GET, INPUT, KEY, LINPUT

OUTLIMIT

TYPE:

Axis Parameter

DESCRIPTION:

The output limit restricts the DAC output to a lower value than the maximum. This can be used to limit the analogue outputs or demand value to a digital drive. **OUTLIMIT** will always limit the DAC output if you are using a servo control or just manually setting DAC.

As it is applied to the output of the closed loop algorithm it is not applied to position based axis.

VALUE:

The range that the DAC is limited to

The value required varies depending on whether the axis has a 12 bit or 16 bit DAC. If the voltage output is generated by a 12 bit DAC values an **OUTLIMIT** of 2047 will produce the full +/-10v range. If the voltage output is generated by a 16 bit DAC values an **OUTLIMIT** of 32767 will produce the full +/-10v range.

EXAMPLE:

Limit a 12bit DAC to ±5V (±1023)

```
    OUTLIMIT AXIS(0)=1023
```

OV_GAIN

TYPE:
Axis Parameter

DESCRIPTION:
The Output Velocity (OV) gain is a gain constant which is multiplied by the change in measured position. The result is summed with all the other gain terms and applied to the servo DAC. Adding **`NEGATIVE`** output velocity gain to a system is mechanically equivalent to adding damping. It is likely to produce a smoother response and allow the use of a higher proportional gain than could otherwise be used, but at the expense of higher following errors. High values may lead to oscillation and produce high following errors. For an output velocity term Kov and change in position DPm, the contribution to the output signal is:

$$O_{ov} = K_{Ov} \times \delta P_m$$

VALUE:
Output velocity gain constant (default = 0)

Negative values are normally required.

P_GAIN

TYPE:
Axis Parameter

DESCRIPTION:
The Proportional gain sets the ‘stiffness’ of the servo response. Values that are too high will produce oscillation. Values that are too low will produce large following errors.

For a proportional gain K_p and position error E, its contribution to the output signal is:

$$O_p = K_p \times E$$

VALUE:
Proportional gain constant (default =1)

EXAMPLE:
Set the **`P_GAIN`** on axis 11 to be a value smaller than the default

```
    P_GAIN AXIS(11)=0.25
```

PEEK

TYPE:
System Function

SYNTAX:

```
value = PEEK(address [,mask])
```

DESCRIPTION:
The **`PEEK`** command returns value of a memory location of the controller ANDed with an optional mask value.

`PEEK` is only normally used for de-bugging purposes and should only be used under the instruction of **Trio Motion Technology**

PARAMETERS:

value:	The value returned from the memory location
address:	The memory address to read
mask:	A value so you can filter particular bits of the address

PI

TYPE:
Constant

DESCRIPTION:
PI is the circumference/diameter constant of approximately 3.14159

EXAMPLES:

EXAMPLE 1:
To print the radius of a circle of given circumference.

```
circum=100
PRINT "Radius = ";circum /(2*PI)
```

EXAMPLE 2:
Set the axis calibration to work in user **UNITS** of Radians.

```
'Motor has 8192 counts per turn.
UNITS = 8192 / (2*PI)
```

PLC_CONFIG

TYPE:
System Parameter (**MC_CONFIG**)

DESCRIPTION:
The **PLC_CONFIG** parameter controls optional features and modes in the IEC61131-3 runtime environment. When a bit is set in the **PLC_CONFIG**, the corresponding mode of operation will be applied to all PLC tasks running in the *Motion Coordinator*.

VALUE:

Bit	Description	Value
0	PLC outputs go OFF when the PLC program is stopped.	1
	PLC outputs stay in the last state when the program is stopped.	0

Outputs may be set **ON** by a BASIC program or by the firmware (e.g. with **PSWITCH**) even when the **PLC** requests to set it **OFF** .

EXAMPLE:

In the **MC_CONFIG** script, set up the PLC system so that all outputs under PLC control will go to the OFF state whenever the program is stopped.

```
PLC_CONFIG = 1
```

Setting this bit affects the action on **STOP** or **HALT**. In the IEC61131-3 environment, not all run-time errors will stop the program. Run-time errors should be explicitly handled in a suitable exception handler.

PLC_ERROR

TYPE:

System Parameter

DESCRIPTION:

PLC_ERROR shows a bit pattern to indicate which processes in the multitasking system, which are running IEC61131-3 PLC tasks, have raised a run-time error flag. There is one bit per PLC task running in the *Motion Coordinator*.

VALUE:

Bit	Description	Value
n	The PLC task running on process *n* has a run-time error.	

EXAMPLE:

In a MC464, IEC61131-3 PLC tasks are set to run on Processes 21 and 20. In the command line terminal, check the value of **PLC_ERROR**. The IEC PLC task on process 20 has a run-time error.

```
>>?HEX(PLC_ERROR)
100000
>>
```

Checking the value in Hexadecimal shows the bit positions clearly. $100000 shows that bit 20 is set. If preferred, the value can be shown in decimal by leaving off the **HEX** modifier. In this case the value 1048576 will be returned.

PLC_OVERFLOW

TYPE:

System Parameter

DESCRIPTION:

PLC_OVERLOW can be used to check that PLC tasks are not exceeding the PLC scan time that has been set for the task. There is one bit per PLC task running in the *Motion Coordinator*.

VALUE:

Bit	Description	Value
n	PLC task running on process *n* has overflowed the configured PLC scan time.	

EXAMPLE:

An IEC61131-3 PLC task is set to run on Process 5 with a scan time of 5 msecs. In the command line terminal, check the value of **PLC_OVERFLOW**. Bit 5 is set, so the PLC task needs to be made smaller or the Scan Time must be increased.

```
>>?HEX(PLC_OVERFLOW)
20
>>
```

Checking the value in Hexadecimal shows the bit position clearly. $20 = 0010 0000 in binary. If preferred, the value can be shown in decimal by leaving off the **HEX** modifier. In this case the value 32 will be returned.

PLC_RUN

TYPE:

System Parameter

DESCRIPTION:

PLC_RUN shows a bit pattern to indicate which processes in the multitasking system are running IEC61131-3 PLC tasks. There is one bit per PLC task running in the *Motion Coordinator*.

VALUE:

Bit	Description	Value
n	A PLC task is running on process *n*.	

EXAMPLE:

IEC61131-3 PLC tasks are set to run on Processes 2, 3 and 6. In the command line terminal, check the value of **PLC_RUN**.

```
>>?HEX(PLC_RUN)
```

```
4c
>>
```

Checking the value in Hexadecimal shows the bit positions clearly. $4c = 0100 1100 in binary. If preferred, the value can be shown in decimal by leaving off the **HEX** modifier. In this case the value 76 will be returned.

PLM_OFFSET

TYPE:
Axis Parameter

DESCRIPTION:
This axis parameter is used exclusively for the SLM interface module and only in PLM (position mode). The parameter allows for an offset between the absolute position within one turn held by the SLM/PLM motor encoder and the zero position in the controller.

It is not normally required to set this parameter as it is configured during the initialisation if the **PLM**.

VALUE:
The offset between the absolute position and the controller zero position.

PMOVE

TYPE:
Process Parameter (Read Only)

DESCRIPTION:
Returns the state of the process move buffer.

When one of the processes encounters a movement command the process loads the movement requirements into its “process move buffer”. This can hold one movement instruction for any group of axes. When the load into the process move buffer is complete the **PMOVE** parameter is set to 1. When the next servo period occurs the motion generation program will load the movement into the “next move buffer” of the required axes if these are available. When this second transfer is complete the **PMOVE** parameter is cleared to 0.

Each process has its own **PMOVE** parameter.

VALUE:

1	the process move buffer is occupied
0	the process move buffer is empty

POKE

TYPE:
System Command

SYNTAX:
`POKE(address, value)`

DESCRIPTION:
The **`POKE`** command allows a value to be entered into a memory location of the controller.

The **`POKE`** command can prevent normal operation of the controller and should only be used if instructed by Trio Motion Technology.

PARAMETERS:

address:	The memory address to read
mask:	A value so you can filter particular bits of the address

PORT

TYPE:
Modifier

SYNTAX:
`PORT(channel)`

DESCRIPTION:
Assigns ONE command, function or port parameter operation to a particular communication **`PORT`**.

PARAMETERS:

channel:	The channel number to use

See the # entry for full listings of all available channels.

POS_OFFSET

TYPE:
Axis Parameter

DESCRIPTION:
For Piezo Motor Control. This sets an offset to the DAC output when the position loop is demanding a positive voltage output. **POS_OFFSET** is applied after **DAC_SCALE** so is always a value appropriate to the D to A converter resolution.

EXAMPLES:

EXAMPLE 1:
An offset of 0.1 volts is required on an axis with a 16 bit D to A converter. With a 16 bit DAC, +10V is commanded with the value 32767 so for 0.1V need 32767 / 100.

```
    POS_OFFSET = 328
```

EXAMPLE 2:
POS_OFFSET and **NEG_OFFSET** are normally used together. It is suggested that the offset is 65% to 70% of the value required to make the stage move in an open loop situation.

```
    POS_OFFSET = 300
    NEG_OFFSET = -270
```

^ Power

TYPE:
Mathematical operator

SYNTAX:
```
<expression1> ^ <expression2>
```

DESCRIPTION:
Raises expression1 to the power of expression2

PARAMETERS:

Expression1:	Any valid TrioBASIC expression
Expression2:	Any valid TrioBASIC expression

EXAMPLE:
Raises the first number (2) to the power of the second number (6).and store it in local variable ‘x’. Then print the value of ‘x’ which is 64.

```
    x=2^6
    PRINT x
```

POWER_UP

TYPE:
Reserved Keyword

PP_STEP

TYPE:
Axis parameter

DESCRIPTION:
`PP_STEP` is an integer multiplier on the encoder value

`UNITS` and `ENCODER_RATIO` should be used in preference to `PP_STEP`

VALUE:
Integer multiplier range (default = 1)

It is recommended to only use values between -1024 and 1023

PRINT

TYPE:
Command.

ALTERNATIVE FORMAT:
`?`

SYNTAX:
`PRINT [#channel,] print_expression`

DESCRIPTION:
The `PRINT` command allows the TrioBASIC program to output a series of characters to a channel. A channel may be a serial port or some other type of connection to the *Motion Coordinator*.

A print_expression may include parameters, fixed `ASCII` strings, single `ASCII` characters and the returned values from functions. Multiple items to be printed can be put on the same `PRINT` line provided they are separated by a comma or semi-colon. The items can be modified using print formatters including HEX, CHR and [w,x]

Any value larger than 1e19 and smaller than 1e-18 will be printed in scientific format. You can still use [w,x] to format how this is displayed. A value is normally printed to 4 decimal places.

PARAMETERS:

#channel,	See # for the full channel list (default 0 if omitted)
print_expression:	A list of variable names (with or without print formatters) and quoted string seperated by commas and/or semicolons

The following elements may be seen in a print_expression:

;	Separates items with no space, omits carriage return line feed if used after the last item.	
,	Separates items with a tab space.	
number[w,x]	Prints a number with a specified width and number of decimal places.	
	w	total number of characters to display, 29 maximum (optional).
	x	number of decimal places to use, 15 maximum.
“string”	Prints the string contained in the quotes .	

When using value[w,x], if the number is too big the field will be filled with question marks to signify that there was not sufficient space to display the number. The numbers are right justified in the field with any unused leading characters being filled with spaces.

EXAMPLES:

EXAMPLE 1:
Print a string using quotation marks.

```
PRINT "CAPITALS and lower case CAN BE PRINTED"
```

EXAMPLE 2:
Print a number and a value from a **VR**, separated by a comma to make the **VR** value in the next tab space.

```
>>PRINT 123.45,VR(1)
123.4500     1.5000
>>
```

EXAMPLE 3:
Print a **VR** with 4 characters and 1 decimal place, then in the next tab a local variable with 2 decimal places.

```
VR(1)=6
variable=410.5:
PRINT VR(1)[4,1],variable[2]
```

print output will be:

```
6.0     410.50
```

EXAMPLE 4:
Print a string directly followed by a numerical value. Note how in this example the semi-colon separator is used. This does not tab into the next column, allowing the programmer more freedom in where the print items are put.

```
>>PRINT "DISTANCE=";MPOS
DISTANCE=123.0000
>>
```

EXAMPLE 5:
Print a carriage return and no line feed at the end of a message. The semi-colon on the end of the print line suppresses the carriage return normally sent at the end of a print line. **ASCII** (13) generates CR without a line feed. The string is to output from serial port channel 1.

```
PRINT #1,"ITEM ";total;" OF ";limit;CHR(13);
```

EXAMPLE 6:
Print the status of inputs 8-16 in hexadecimal format to terminal channel 5 in *Motion* Perfect.

```
PRINT #5, HEX(IN(8,16))
```

EXAMPLE 7:
Print **AXISSTATUS** for axis 6 in the hexadecimal format on the command line. (bits 1 and 8 are set)

```
>>?hex(AXISSTATUS AXIS(6))
102
>>
```

SEE ALSO:
#, CHR, HEX, DATE$, DAY$, TIME$

PRMBLK

TYPE:
Reserved Keyword

PROC

TYPE:
Modifier

DESCRIPTION:
Allows a particular process to be specified when using a Process Parameter, Function or Command.

EXAMPLE:
Run a program on a particular process then watch that process to see when it finishes.

```
RUN “MOTION”,2
‘Wait for the program to start running
WAIT UNTIL PROC_STATUS PROC(2) <>0
‘Wait for the program to complete and flash an OP
REPEAT
  OP(10,ON)
  WA(100)
  OP(10,OFF)
  WA(50)
UNTIL PROC_STATUS PROC(2) = 0
```

PROC_LINE

TYPE:
Process Parameter (Read Only)

DESCRIPTION:
Allows the current line number of another executing program to be obtained.

EXAMPLE:

Find out which line is being executed on the program running in process 2.

```
>>PRINT PROC_LINE PROC(2)
12
>>
```

PROC_STATUS

TYPE:

Process Parameter (Read Only)

DESCRIPTION:

Returns the status of another process, referenced with the **PROC**(x) modifier.

VALUE:

0	Process Stopped
1	Process Running
2	Process Stepping
3	Process Paused
4	Process Pausing
5	Process Stopping

EXAMPLE:

Run a program in process 12, check for it to start and then for it to complete.

```
RUN “progname”,12
WAIT UNTIL PROC_STATUS PROC(12)<>0 ‘ wait for program to start
WAIT UNTIL PROC_STATUS PROC(12)=0
‘ Program “progname” has now finished.
```

PROCESS

TYPE:

System Command (Command line only)

DESCRIPTION:
Displays information about the running processes.

There are some housekeeping process that you cannot stop.

RETURNED VALUES:

Process:	The process number
Type:	The Type of process executing
Status:	The execution state of the process
Program:	The name of the program running in the process
Line:	The line number of a program that is executing
Time:	The length of time that the process has been running
CPU:	The percentage of CPU time used by the process

EXAMPLE:
Check the state of the processes in the command line.

```
>>process
Process   Type   Status    Program     Line     hhhh:mm:ss.ms    [CPU  %]
-------   ----   ------    --------    -----    -------------    --------
21        Fast   Sleep     [0] TEST    1        0000:00:02.634   [ 0.23%]
22        SYS    Run       Command Line         0001:14:05.570   [ 0.16%]
23        SYS    Run       IO Server            0001:14:01.183   [90.46%]
24        SYS    Sleep[8]  MPE                  0001:14:05.571   [ 0.00%]
25        SYS    Sleep[6]  CAN Server           0001:14:05.571   [ 0.00%]
KERNEL    SYS    Run       Motion/Housekeeping  0001:14:05.571   [ 9.16%]
>>
```

PROCNUMBER

TYPE:
System Parameter

DESCRIPTION:
Returns the process on which a TrioBASIC program is running. This is normally required when multiple copies of a program are running on different processes.

VALUE:
The process number the current program is running on

EXAMPLE:
Running the same program on processes 0 to 3 to use axes 0-3, **PROCNUMBER** is used to specify which axis the program is using.

```
    MOVE(length) AXIS(PROCNUMBER)
```

PROJECT_KEY

TYPE:
System Command

SYNTAX:
PROJECT_KEY key_string security_code_type

DESCRIPTION:
Used in the **TRIOINIT**.BAS script file on an SD card to enable loading of an encrypted project.

The project key is generated by *Motion* Perfect when encrypting a project

PARAMETERS:

key_string	A string which is the project key generated by *Motion* Perfect	
security_code_type	0 (optional)	Controller security code
	1	OEM security code
	2	User security code

EXAMPLES:

EXAMPLE 1:
Use the SD card to load a project that was previously encrypted by the *Motion* Perfect using the controller security code.

```
    '============================================================
    ' Application: SDCARD startup file
    ' Filename: TRIOINIT.BAS
    ' Platform: MC4xx
    '
    ' Use the Project Encryptor to generate the PROJECT_KEY which
    ' is specific to the target Motion Coordinator's serial number.
    '
    '------------------------------------------------------------
    PROJECT_KEY "MyKey"
    FILE "LOAD_PROJECT" "MyEncryptedProject" 'load desired project
```

EXAMPLE 2:

Use the SD card to load a project that was previously encrypted by the *Motion* Perfect using the user security code.

```
    '============================================================
    ' Application: SDCARD startup file
    ' Filename: TRIOINIT.BAS
    ' Platform: MC4xx
    '
    ' Use the Project Encryptor to generate the PROJECT_KEY which
    ' is specific to the target Motion Coordinator's serial number.
    '
    '------------------------------------------------------------
    PROJECT_KEY " c8NaHIvA.tU"2
    FILE "LOAD_PROJECT" "MyEncryptedProject" 'load desired project
```

SEE ALSO:

FILE, VALIDATE_ENCRYPTION_KEY, SET_ENCRYPTION_KEY

PROTOCOL

TYPE:

Port Parameter

DESCRIPTION:

This parameter allows the user to check which protocol is running on the specified **PORT**.

You can write to this parameter however it is advisable to initialise the communication protocol through **SETCOM**, **ANYBUS** etc.

Do not write a value to **PORT**(0) as you will disable communications with *Motion* Perfect.

VALUE:

0	None
1	Download
2	MPE
3	**MODBUS**
4	Transparent
5	HostLink

EXAMPLE:

Check that Modbus is running on the RS485 channel (**PORT**(2))

```
IF PROTOCOL PORT(2) <>3 THEN
  PRINT#user, “MODBUS has stopped”
ENDIF
```

SEE ALSO:

ANYBUS, SETCOM

PS_ENCODER

TYPE:

Axis Parameter (Read Only)

DESCRIPTION:

The **PS_ENCODER** axis parameter holds a raw copy of the positional feedback device used for the hardware p-switch.

VALUE:

The 30bit value used for hardware p-switch encoder

SEE ALSO:

HW_PSWITCH

PSWITCH

TYPE:
Command

SYNTAX:
`PSWITCH(switch, enable [,axis, output, state, setpos, resetpos])`

`PSWITCH(switch, OFF [, hold])`

DESCRIPTION:
The **PSWITCH** command allows an output to be set when a predefined position is reached, and to be reset when a second position is reached. There are 64 position switches each of which can be assigned to any axis and to any output, virtual or real.

Multiple **PSWITCH**'s can be assigned to a single output.

The actual output is the **OR** of all position switches on the output **OR** the **OP** setting. This means that **OP**(output,**ON**) can override a **PSWITCH**.

When switching the **PSWITCH** *OFF*, the output will remain at the current state unless the hold parameter is set to 1. (Hold requires firmware 2.0226 or later)

PARAMETERS:

switch:	The switch number in the range 0..63	
enable:	1 or ON	Enable software **PSWITCH** (requires all parameters)
	0 or OFF	Disable **PSWITCH**
	5	Enable **PSWITCH** on **DPOS**
axis:	Axis to link the **PSWITCH** to, may be any real or virtual axis.	
output:	Selects the output to set, can be any real or virtual output.	
state:	1 or ON	turn the output ON at setpos
	0 or OFF	turn the output OFF at setpos
setpos:	The position at which output is set, in user units	
resetpos:	The position at which output is reset, in user units	

hold:	0	The **PSWITCH** output will hold in the same state it was when the **PSWITCH** is set to OFF. (Default)
	1	The **PSWITCH** output is forced OFF even if it was ON when the **PSWTICH** is set to OFF.

EXAMPLE 1:

A rotating shaft has a cam operated switch which has to be changed for different size work pieces. There is also a proximity switch on the shaft to indicate TDC of the machine. With a mechanical cam the change from job to job is time consuming but this can be eased by using the **PSWITCH** as a software ‘cam switch’. The proximity switch is wired to input 7 and the output is fired by output 11. The shaft is controlled by axis 0 of a 3 axis system. The motor has a 900ppr encoder. The output must be on from 80° after TDC for a period of 120°. It can be assumed that the machine starts from TDC.

The **PSWITCH** command uses the unit conversion factor to allow the positions to be set in convenient units. So first the unit conversion factor must be calculated and set. Each pulse on an encoder gives four edges which the controller counts, therefore there are 3600 edges/rev or 10 edges/°. If we set the unit conversion factor to 10 we can then work in degrees.

Next we have to determine a value for all the **PSWITCH** parameters.

This can all be put together to form the two lines of TrioBASIC code that set up the position switch:

axis	We are told that the shaft is controlled by axis 0, thus axis is set to 0.
output	We are told that output 11 is the one to fire, so this is 11.
state	When the output is set it should be ON.
setpos	The output is to fire at 80° after TDC hence the set position is 80 as we are working in degrees.
resetpos	The output is to be on for a period of 120° after 80° therefore it goes off at 200°. So the reset position is 200.

```
switch:
  UNITS AXIS(0)=10'   Set unit conversion factor (°)
  REPDIST=360
  REP_OPTION=ON
  PSWITCH(0,ON,0,11,ON,80,200)
```

This program uses the repeat distance set to 360 degrees and the repeat option ON so that the axis position will be maintained in the range 0..360 degrees.

EXAMPLE 2:

PSWITCH number 7 has been running on axis 5 controlling output 14. It must be disabled and the output set to OFF at the same time.

```
PSWITCH(7,OFF,1)
```

Or the same **PSWITCH** must be disabled but the output not changed until some event later. The later event is controlled by a reset push button on input 23.

```
PSWITCH(7,OFF,0)
WA(1)  ` wait one servo cycle for the PSWITCH to disable
IF READ_OP(14)=ON THEN
  WAIT UNTIL IN(23)=ON
  OP(14,OFF)
ENDIF
```

‘ Quote

TYPE:

Special Character

SYNTAX:

```
`text
```

DESCRIPTION:

A single quote ‘ is used to mark the rest of a line as being a comment only with no execution significance.

Comments use memory space and so should be concise in very long programs. Comments have no effect on execution speed since they are not present in the compiled code.

PARAMETERS:

Text	any text string

EXAMPLE:

Adding comment lines and comments after executable sections of code.

```
`PROGRAM TO ROTATE WHEEL
turns=10
`turns contains the number of turns required
MOVE(turns)’ the movement occurs here
```

R_MARK

TYPE:
Axis Parameter (Read Only)

SYNTAX:
`R_MARK(expression)`

DESCRIPTION:
This parameter can be polled to determine if the registration event has occurred.

This is an **AXIS** parameter, you need to ensure that you are using this parameter with the same **AXIS** that you used to set the **REGIST**.

R_MARK is reset when **REGIST** is executed

PARAMETERS:

Expression:	Any valid TrioBASIC expression. The result of the expression should be a valid integer channel number.

VALUE:

FALSE	The registration event has not occurred
TRUE	The registration event has occurred (default)
< -1	Quantity of registration events have been logged to the **TABLE**

When **TRUE** the **R_REGPOS** is valid.

EXAMPLE:
Apply an offset to the position of the axis depending on the registration position.

```
loop:
  WAIT UNTIL IN(punch_clr)=ON
  MOVE(index_length)
  REGIST(21, 1, 0, 0) 'rising edge input channel 1
  WAIT UNTIL R_MARK(1)
  MOVEMODIFY(R_REGPOS(1) + offset)
  WAIT IDLE
GOTO loop
```

SEE ALSO:

REGIST, R_REGPOS, R_REGISTSPEED

R_REGISTSPEED

TYPE:

Axis Parameter (Read Only)

SYNTAX:

R_REGISTSPEED(expression)

DESCRIPTION:

Stores the speed of the axis when a registration mark was seen. Value is in user units per millisecond. This parameter is used with the time based registration channel set with the **REGIST** command.

In most real-world systems there are delays built into the registration circuit; the external sensor and the input opto-isolator will have some fixed response time. As machine speed increases, the fixed electrical delays will have an effect on the captured registration position.

R_REGISTSPEED returns the value of axis speed captured at the same time as **R_REGPOS**. The captured speed and position values can be used to calculate a registration position that does not vary with speed because of the fixed delays.

This is an **AXIS** parameter, you need to ensure that you are using this parameter with the same **AXIS** that you used to set the **REGIST** so to ensure that the correct **UNITS** are used.

PARAMETERS:

Expression:	Any valid TrioBASIC expression. The result of the expression should be a valid integer channel number.

VALUE:

The speed of the axis in user units per millisecond at which the registration event occurred.

This parameter has the units of **UNITS**/msec at all **SERVO_PERIOD** settings.

EXAMPLE:

Compensate for fixed delays in the registration circuit using **R_REGISTSPEED**.

```
    fixed_delays=0.012 ‘ circuit delays in milliseconds
    REGIST(21, 3, 0, 0, 0) ‘ registration on time based channel 3
    WAIT UNTIL R_MARK(3)
    captured_position = R_REGPOS(3)-(R_REGISTSPEED(3)*fixed_delays)
```

SEE ALSO:

REGIST, **REGIST_SPEED**, **REGIST_SPEEDB**

R_REGPOS

TYPE:

Axis Parameter (Read Only)

SYNTAX:

R_REGPOS(expression)

DESCRIPTION:

Stores the latest position at which a registration mark was seen on the axis in user units. This parameter is used with the time based registration channel that was set by the **REGIST** command.

This is an **AXIS** parameter, you need to ensure that you are using this parameter with the same **AXIS** that you used to set the **REGIST** so to ensure that the correct **UNITS** are used.

PARAMETERS:

Expression:	Any valid TrioBASIC expression. The result of the expression should be a valid integer channel number.

VALUE:

The absolute position in user **UNITS** at which the registration event occurred.

EXAMPLE:

A paper cutting machine uses a cam profile shape to quickly draw paper through servo driven rollers then stop it whilst it is cut. The paper is printed with a registration mark. This mark is detected and the length of the next sheet is adjusted by scaling the cam profile with the third parameter of the CAM command:

```
    ` Example Registration Program using CAM stretching:
    ` Set window open and close:
      length=200
      OPEN_WIN=100
      CLOSE_WIN=130
      GOSUB Initial
    Loop:
      TICKS=0             `Set millisecond counter to 0
      IF R_MARK(0) THEN
        offset=R_REGPOS(0)
        'This next line makes offset -ve if at end of sheet:
        IF ABS(offset-length)<offset THEN offset=offset-length
        PRINT "Mark seen at:"offset[5,1]
      ELSE
        offset=0
        PRINT "Mark not seen"
      ENDIF

      ' Reset registration prior to each move:
      DEFPOS(0)
      REGIST(32,0,0,0,1) 'Allow mark to be seen between 100 and 130
      CAM(0,50,(length+offset*0.5)*cf,1000)
      WAIT UNTIL TICKS<-500
      GOTO Loop
```

(variable "cf" is a constant which would be calculated depending on the machine draw length per encoder edge)

SEE ALSO:

REGIST, **REG_POS**, **REG_POSB**

RAISE_ANGLE

TYPE:

Axis Parameter

DESCRIPTION:

This parameter is used with **CORNER_MODE**, it defines the maximum change in direction of a 2 axis interpolated move before **CORNER_STATE** is triggered. When the change in direction is greater than this angle **CORNER_STATE** will change state so the system can interact with a program.

This can be used to change the angle of a cutting knife

RAISE_ANGLE does not control the speed so it should be set equal or greater than **STOP_ANGLE**.

VALUE:

The angle to start to interact with a program through **CORNER_STATE**

EXAMPLE:

Decelerate to a slower speed when the transition is between 15 and 45 degrees. If the transition is greater than 45degrees stop so that a **CORNER_STATE** routine can run.

```
    CORNER_MODE=2 + 4
    DECEL_ANGLE = 15 * (PI/180)
    STOP_ANGLE = 45 * (PI/180)
    RAISE_ANGLE= STOP_ANGLE
```

SEE ALSO:
CORNER_MODE, CORNER_STATE, DECEL_ANGLE, STOP_ANGLE

.. (Range)

TYPE:
Reserved Keyword

RAPIDSTOP

TYPE:
Axis Command

SYNTAX:
RAPIDSTOP [(mode)]

ALTERNATE FORMAT:
RS

DESCRIPTION:
The **RAPIDSTOP** command cancels the currently executing move on ALL axes. Velocity profiled moves, for example; **FORWARD**, **REVERSE**, **MOVE**, **MOVEABS**, **MOVECIRC**, **MHELICAL**, **MOVEMODIFY**, will be ramped down at the programmed **DECEL** or **FASTDEC** rate then terminated. Other move types will be terminated immediately.

PARAMETERS:

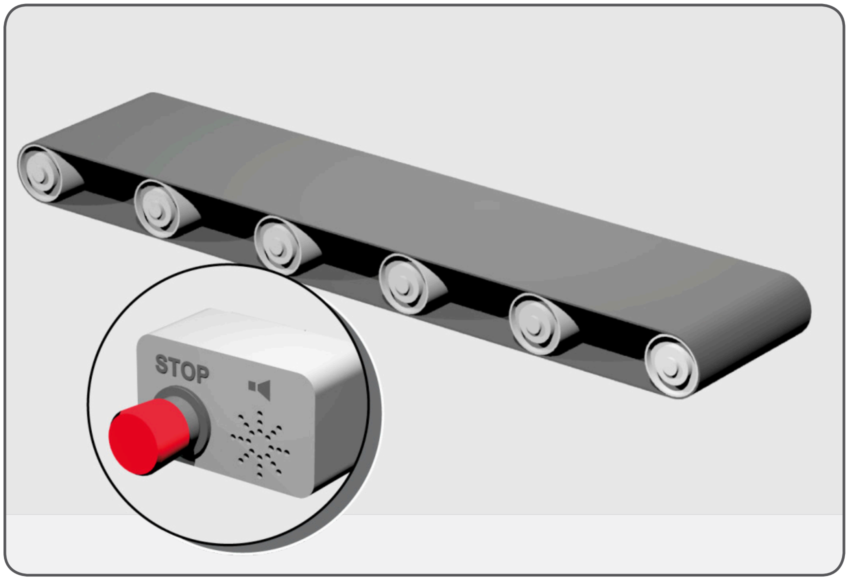
mode:	0 or none	Cancels axis commands from the **MTYPE** buffers
	1	Cancels all buffered moves on all axis (excluding the **PMOVE**)
	2	Cancels all active and buffered moves including the **PMOVE**

RAPIDSTOP will only cancel the presently executing moves. If further moves are buffered they will then be loaded and the axis will not stop.

EXAMPLES:

EXAMPLE 1:

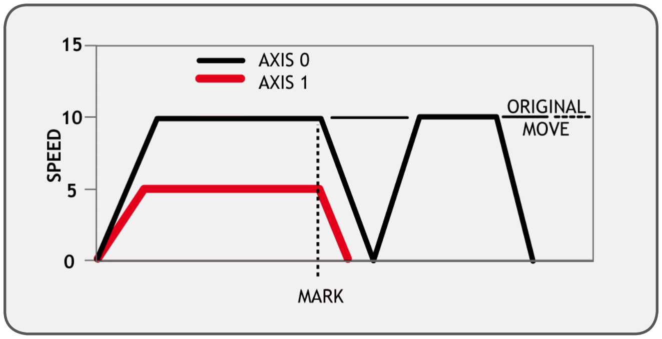
Implementing a stop override button that cuts out all motion.



```
CONNECT (1,0) AXIS(1)       'axis 1 follows axis 0
BASE(0)
REPAEAT
  MOVE(1000) AXIS (0)
  MOVE(-100000) AXIS (0)
  MOVE(100000) AXIS (0)
UNTIL IN (2)=OFF            'stop button pressed?
RAPIDSTOP(2)
```

EXAMPLE 2:

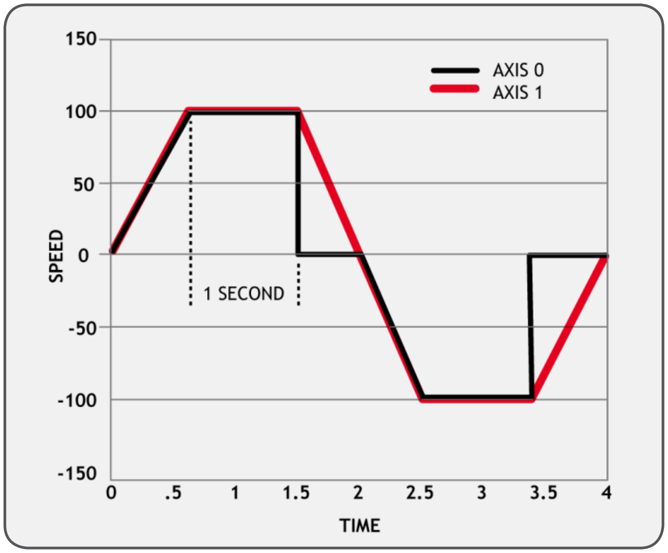
Using **RAPIDSTOP** to cancel a **MOVE** on the main axis and a **FORWARD** on the second axis. After the axes have stopped, a **MOVEABS** is applied to re-position the main axis.



```
    BASE(0)
    REGIST(3)
    FORWARD AXIS(1)
    MOVE(100000)  'apply a long move
    WAIT UNTIL MARK
    RAPIDSTOP
    WAIT IDLE     'for MOVEABS to be accurate, the axis must stop
    MOVEABS(3000)
```

EXAMPLE 3:

Using **RAPIDSTOP** to break a connect, and stop motion. The connected axis stops immediately on the **RAPIDSTOP** command, the forward axis decelerates at the decel value.



```
    BASE(0)
    CONNECT(1,1)
    FORWARD AXIS(1)
    WAIT UNTIL VPSPEED=SPEED 'let the axis get to full speed
    WA(1000)
    RAPIDSTOP
    WAIT IDLE AXIS(1)       'wait for axis 1 to decel
    CONNECT(1,1)            're-connect axis 0
    REVERSE AXIS(1)
    WAIT UNTIL VPSPEED=SPEED
    WA(1000)
    RAPIDSTOP
    WAIT IDLE AXIS(1)
```

SEE ALSO:

CANCEL, FASTDEC

READ_BIT

TYPE:

Logical and Bitwise Command

SYNTAX:

READ_BIT(bit, variable)

DESCRIPTION:

READ_BIT can be used to test the value of a single bit within a **VR**() variable.

PARAMETERS:

bit:	The bit number to clear, valid range is 0 to 52
variable:	The **VR** which to operate on

EXAMPLE:

Read bit 4 of **VR**(13).

```
    Result = READ_BIT(4,13)
```

SEE ALSO:

SET_BIT, CLEAR_BIT

READ_OP

TYPE:
System Command

SYNTAX:
`value = READ_OP(output [,finaloutput])`

DESCRIPTION:
Returns the state of digital output logic.

If called with one parameter, it returns the state (1 or 0) of that particular output channel. If called with 2 parameters **`READ_OP`**() returns, in binary, the sum of the group of outputs.

`READ_OP` checks the state of the output logic. The output may be virtual or not powered and you will still see the logic state.

PARAMETERS:

value:	The binary pattern of the selected outputs
output:	Output to return the value of/start of output group
finaloutput:	Last output of group

The range of output to final output must not exceed 32

EXAMPLES:

EXAMPLE 1:
In this example a single output is tested:

```
test:
  WAIT UNTIL READ_OP(12)=ON
  GOSUB place
```

EXAMPLE 2:
Check the group of 8 outputs and call a routine if any of them are ON.

```
op_bits = READ_OP(16,23)
IF op_bits<>0 THEN
  GOSUB check_outputs
ENDIF
```

READPACKET

TYPE:
Command

SYNTAX:
`READPACKET(port, variable, count [,format])`

DESCRIPTION:
READPACKET is used to read in data to the **VR** variables over a serial communications port. The data is transmitted from the PC in binary format with a CRC 16bit checksum. There are four different data formats, all use the same packet structure:

Data					CRC	
Byte 0	Byte 1	Byte 2	...	Byte n	Byte 0	Byte 1

The 16bit checksum uses the generator polynomial:
$x^{16}+x^{15}+x^{2}+x^{0}$ or $8005

PARAMETERS:

port:	This value should be 0 to 2	
pariable:	This value tells the *Motion Coordinator* where to start setting the variables in the **VR**() global memory array.	
VR count:	The number of variables to download, maximum 250	
format:	The number format for the numbers being downloaded	
	0	Standard character
	1	Standard integer
	2	Standard long
	4	7bit long

Depending on the format used the data may be split over multiple bytes. It is up to the user to recombine these to get the final value.

FORMAT = 0 (STANDARD CHARACTER)
Each value is in each Byte:

Value0 = Byte 0
Value1 = Byte 1
…

FORMAT = 1 (STANDARD INTEGER)

Each value is split over 2Bytes:

Value0 = Byte1 * 256 + Byte0
Value1 = Byte3 * 256 + Byte2
…

FORMAT = 2 (STANDARD LONG)

Each value is split over 4Bytes

Value0 = ((Byte3 * 256 + Byte2) * 256 + Byte1) * 256 +Byte0
Value1 = ((Byte7 * 256 + Byte6) * 256 + Byte5) * 256 +Byte4
…

FORMAT = 4 (7BIT LONG)

Each value is split over 4Bytes, but only uses 7 bits of each byte. Only Byte 0 (including the CRC) has bit 7 set. The values sent are therefore 24bits in length.

Bits 15 and Bits 7 of the CRC are not sent and so ignored by the check.

Value0 = ((Byte3 * 128 + Byte2) * 128 + Byte1) * 128 + Byte0
Value1 = ((Byte7 * 128 + Byte6) * 128 + Byte5) * 128 + Byte4
…

EXAMPLE:

Using Standard Long (format = 2) read in the values to a sequence of **VR**'s starting at 0 from port 1. The bytes from the **READPACKET** command are stored in **VR**(100) and onwards.

```
READPACKET(1, 100, 10, 2)
FOR value = 0 to 9
  'Off set the bytes
  VR(value*4+103) = VR(value*4+103) * (2^32)
  VR(value*4+102) = VR(value*4+103) * (2^16)
  VR(value*4+101) = VR(value*4+103) * (2^8)
  VR(value)=(value*4+103)+VR(value*4+102))+VR(value*4+101))_
    +VR(value*4+100)
NEXT value
```

REG_INPUTS

TYPE:
Axis Parameter

DESCRIPTION:
Selects which of the hardware registration inputs to use for an axis. When using **REGIST** modes 3 to 17 the first input is the A channel and the second is the B.

It is recommended to use **REGIST**(20 to 22) for new projects.

On the MC464 FlexAxis the following defaults are used:

Axis	First input	Second input
0	0	4
1	1	5
2	2	6
3	3	7
4	4	0
5	5	1
6	6	2
7	7	3

VALUE:

Bits	function

3:0	Selects the first input for the axis registration	
	0000	FlexAxis Input 0
	0001	FlexAxis Input 1
	0010	FlexAxis Input 2
	0011	FlexAxis Input 3
	0100	FlexAxis Input 4
	0101	FlexAxis Input 5
	0110	FlexAxis Input 6
	0111	FlexAxis Input 7
7:4	Selects the second input for the axis registration	
	0000	FlexAxis Input 0
	0001	FlexAxis Input 1
	0010	FlexAxis Input 2
	0011	FlexAxis Input 3
	0100	FlexAxis Input 4
	0101	FlexAxis Input 5
	0110	FlexAxis Input 6
	0111	FlexAxis Input 7

EXAMPLE:
Set registration input 2 as the first inputs and 7 as the second

```
    REG_INPUTS=$72
```

REG_POS

TYPE:
Axis Parameter (Read Only)

ALTERNATE FORMAT:
`RPOS`

DESCRIPTION:

Stores the latest position at which a registration mark was seen on each axis in user **UNITS**. This parameter is used with the first (A) hardware registration channel, or Z mark only.

VALUE:

The absolute position in user **UNITS** at which the registration event occurred.

EXAMPLE:

A paper cutting machine uses a cam profile shape to quickly draw paper through servo driven rollers then stop it whilst it is cut. The paper is printed with a registration mark. This mark is detected and the length of the next sheet is adjusted by scaling the cam profile with the third parameter of the CAM command:

```
    `  Example Registration Program using CAM stretching:
    ` Set window open and close:
      length=200
      OPEN_WIN=10
      CLOSE_WIN=length-10
      GOSUB Initial
    Loop:
      TICKS=0      'Set millisecond counter to 0
      IF MARK THEN
        offset=REG_POS
        'This next line makes offset -ve if at end of sheet:
        IF ABS(offset-length)<offset THEN offset=offset-length
        PRINT "Mark seen at:"offset[5.1]
      ELSE
        offset=0
        PRINT "Mark not seen"
      ENDIF

      'Reset registration prior to each move:
      DEFPOS(0)
      REGIST(3+768)' Allow mark at first 10mm/last 10mm of sheet
      CAM(0,50,(length+offset*0.5)*cf,1000)
      WAIT UNTIL TICKS<-500
      GOTO Loop
```

(variable "cf" is a constant which would be calculated depending on the machine draw length per encoder edge)

SEE ALSO:

REGIST, **REG_POSB**, **R_REGPOS**

REG_POSB

TYPE:
Axis Parameter (Read Only)

DESCRIPTION:
Stores the latest position at which a registration mark was seen on each axis in user units. This parameter is used with the second (B) hardware registration channel, or Z mark only.

VALUE:
The absolute position in user **UNITS** of where the registration event occurred.

EXAMPLE:
Detect the front and rear edges of an object on a conveyor and measure its length.

```
 ‘ Registration on rising edge R0 and falling edge R1
REGIST(11)
WAIT UNTIL MARK
position1 = REG_POS
WAIT UNTIL MARKB
position2 = REG_POSB

length = position2 - position1
```

SEE ALSO:
REGIST, **REG_POS**, **R_REGPOS**

REGIST

TYPE:
Axis Command

SYNTAX:
`REGIST(mode [,parameters])`

DESCRIPTION:
The **REGIST** command initiates a capture of an axis position when it sees a registration input or the Z mark on the encoder. Once a registration event is captured **MARK** is set and the position and speed at the event can be read back.

See the Hardware Chapter of the manual to understand which registration mode your hardware supports.

Filtering can be applied to the input as well as defining a window of where to capture.

Hardware registration captures the encoder count against the registration input in hardware

Time based registration captures the time of the registration event and interpolates the position values being sent back from the drive against it.

Although all modes are available for backwards compatibility it is recommended to use modes 20-22 for new applications. Other modes have been provided for compatibility with older products.

The **REGIST** command must be re-issued for each position capture.

The captured registration position may be outside **REP_DIST**. You should always check the captured registration position to ensure it is within your applications usable range.

PARAMETERS:

mode:	1..4	Single channel hardware registration
	5	Reserved
	6..13	Dual channel hardware registration
	14..17	Single channel hardware registration
	20	Single channel hardware registration
	21	Single channel time based registration
	22	8 channel hardware registration
	23	Sets 2.4usec minimum pulse width
	24	Sets 0.15usec minimum pulse width (default)
	32..39	Rising edge on time based registration (use mode 21)
	64..71	Falling edge on time based registration (use mode 21)

MODE = 1..4:

SYNTAX:

REGIST(mode)

Where mode = 1..4

DESCRIPTION:

It is recommend that you use mode 20 for all new applications

Modes 1 to 4 work with the first channel or Z mark of hardware based registration.

You can add 256 or 768 to enable windowing.

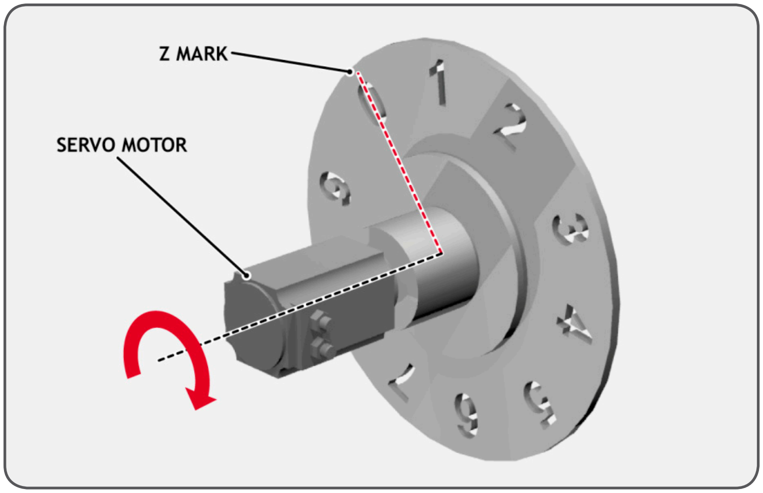
This mode works with **MARK**, **REG_POS** and **REGIST_SPEED**

PARAMETERS:

mode:	1	Z Mark rising into **REG_POS**
	2	Z Mark falling into **REG_POS**
	3	RA Input rising into **REG_POS**
	4	RA Input falling into **REG_POS**
	mode + 256	Position must be inside **OPEN_WIN..CLOSE_WIN**
	mode + 768	Position must be outside **OPEN_WIN..CLOSE_WIN**

EXAMPLE:

A disc used in a laser printing process requires registration to the Z marker before printing can start. This routine locates to the Z marker, then sets that as the zero position.



```
BASE(0)
REGIST(1)          'Initialise to Z mark
FORWARD            'start movement
WAIT UNTIL MARK
CANCEL             'stops movement after Z mark
WAIT IDLE
MOVEABS (REG_POS)  'relocate to Z mark
WAIT IDLE
DEFPOS(0)          'set zero position
```

MODE = 6..13:

SYNTAX:

REGIST(6..13)

Where mode = 6..13

DESCRIPTION:

It is recommend that you use mode 20 for all new applications

Modes 6 to 13 work with hardware based registration but enable you to arm 2 registration registers at once.

You can add 256 or 768 to enable windowing.

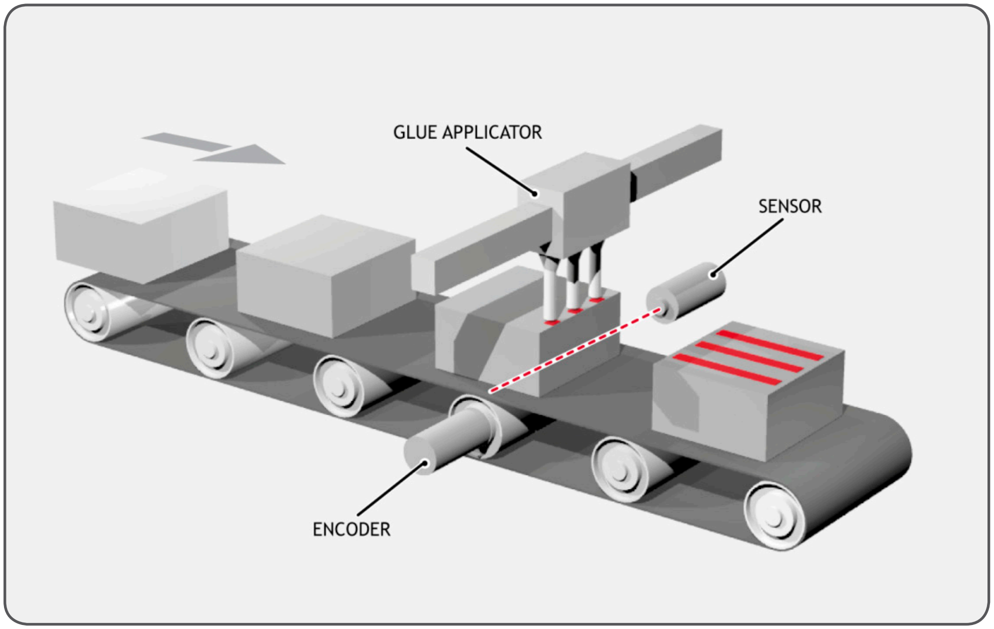
The first channel will use **MARK**, **REG_POS** and **REGIST_SPEED** and the second will use **MARKB**, **REG_POSB** and **REGIST_SPEEDB**

PARAMETERS:

mode:	6	RA Input rising into **REG_POS** & Z Mark rising into **REG_POSB**
	7	RA Input rising into **REG_POS** & Z Mark falling into **REG_POSB**
	8	RA Input falling into **REG_POS** & Z Mark rising into **REG_POSB**
	9	RA Input falling into **REG_POS** & Z Mark falling into **REG_POSB**
	10	RA Input rising into **REG_POS** & RB Input rising into **REG_POSB**
	11	RA Input rising into **REG_POS** & RB Input falling into **REG_POSB**
	12	RA Input falling into **REG_POS** & RB Input rising into **REG_POSB**
	13	RA Input falling into **REG_POS** & RB Input falling into **REG_POSB**
	mode + 256	Position must be inside **OPEN_WIN..CLOSE_WIN**
	mode + 768	Position must be outside **OPEN_WIN..CLOSE_WIN**

EXAMPLE:

A machine adds glue to the top of a box by switching output 8. It must detect the rising edge (appearance) of and the falling edge (end) of a box. Additionally it is required that the **MPOS** be reset to zero on the detection of the Z position.



```
reg=6 'select registration mode 6 (rising edge R, rising edge Z)
REGIST(reg)
FORWARD
WHILE IN(2)=OFF
  IF MARKB THEN  'on a Z mark MPOS is reset to zero
    OFFPOS=-REG_POSB
    REGIST(reg)
  ELSEIF MARK THEN  'on R input output 8 is toggled
    IF reg=6 THEN
      'select registration mode 8 (falling edge R, rising edge Z)
      reg=8
      OP(8,ON)
    ELSE
      reg=6
      OP(8,OFF)
    ENDIF
    REGIST(reg)
  ENDIF
WEND
CANCEL
```

MODE = 14..17:

SYNTAX:

REGIST(mode)

Where mode = 14..17

DESCRIPTION:

It is recommend that you use mode 20 for all new applications

Modes 14 to 17 work with the second channel or Z mark of hardware based registration.

You can add 256 or 768 to enable windowing.

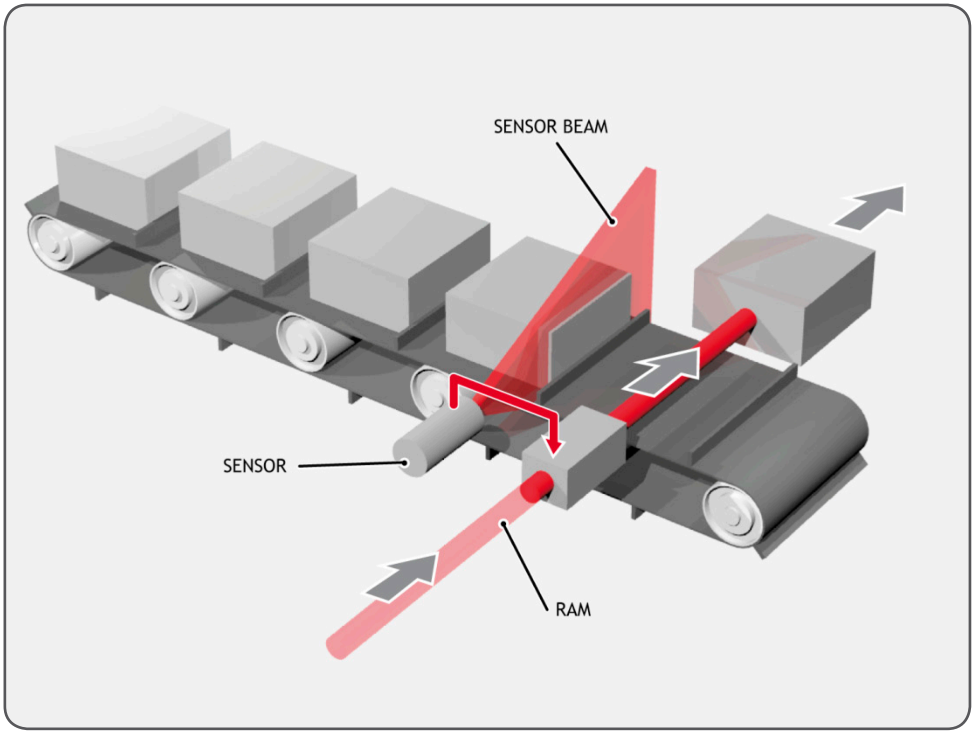
This mode works with **MARKB**, **REG_POSB** and **REGIST_SPEEDB**

PARAMETERS:

mode:	14	ZB Mark rising into **REG_POSB**
	15	ZB Mark falling into **REG_POSB**
	16	RB Input rising into **REG_POSB**
	17	RB Input falling into **REG_POSB**
	mode + 256	Position must be inside **OPEN_WIN..CLOSE_WIN**
	mode + 768	Position must be outside **OPEN_WIN..CLOSE_WIN**

EXAMPLE:

It is required to detect if a component is placed on a flighted belt so windowing is used to avoid sensing the flights. The flights are at a pitch of 120 mm and the component will be found between 30 and 90mm. If a component is found then an actuator is fired to push it off the belt.



```
REP_DIST=120        'sets repeat distance to pitch of belt flights
REP_OPTION=ON
```

```
OPEN_WIN=30             'sets window open position
CLOSE_WIN=90            'sets window close position
REGIST(17+256)           'RB input registration with windowing
FORWARD                  'start the belt
box_seen=0
REPEAT
  WAIT UNTIL MPOS<60  'wait for centre point between flights
  WAIT UNTIL MPOS>60  'so that actuator is fired between flights
  IF box_seen=1 THEN  'was a box seen on the previous cycle?
    OP(8,ON)          'fire actuator
    WA(100)
    OP(8,OFF)         'retract actuator
    box_seen=0
  ENDIF
  IF MARKB THEN box_seen=1 'set "box seen" flag
  REGIST(17+256)
UNTIL IN(2)=OFF
CANCEL                'stop the belt
WAIT IDLE
```

MODE = 20:

SYNTAX:

REGIST(20, channel, source, edge, window [,quantity, table_start])

DESCRIPTION:

Mode 20 is used to set the hardware registration inputs A or B. Alternatively A or B can be replaced with the Z mark. A and B are completely independent.

When using a FlexAxis the actual input used for channel A and channel B can be selected with the **REG_INPUTS** command.

This mode can be used instead of **REGIST** modes 1..4 and 14..17

If the optional parameters quantity and table_start are used then a set of registration positions can be stored in the table. **REG_POS** and **REG_POSB** will still store the latest registration position.

PARAMETERS:

channel:	0	Selects channel A
	1	Selects channel B
	0 .. 511	Digital input selection when source set to 4
source:	0	Selects the first 24V input.
	1	Selects the Z mark.
	2	Selects the second 24V input
	3	Selects the 5V registration pin (built-in axis only)
	4	Selects any digital input as source, used on any axis
edge:	0	Rising edge
	1	Falling edge
window:	0	No windowing
	1	Position must be inside **OPEN_WIN..CLOSE_WIN**
	2	Position must be outside **OPEN_WIN..CLOSE_WIN**
quantity	1 - **TSIZE**	Quantity of registration captures to store in the **TABLE**
table_start	0 -**TSIZE**	Start position in the **TABLE** for the registration positions

If channel = 0 then *MARK*, *REG_POS* and *REGIST_SPEED* are used
If channel = 1 then *MARKB*, *REG_POSB* and *REGIST_SPEEDB* are used

If source = 4 then *MARK*, *REG_POS* and *REGIST_SPEED* are used, but only values at the nearest servo period tick are captured. (not a true hardware registration)

EXAMPLE:

Configure the windowing which will be used on channel B and then arm both channel B and the Z mark.

```
OPEN_WIN=200
CLOSE_WIN=400
REGIST(20,0,1,0,0)
REGIST(20,1,0,1,2)
```

MODE = 21:

SYNTAX:

`REGIST(21, channel, source, edge, window [,quantity, table_start])`

DESCRIPTION:

REGIST mode 21 is used to arm the time based registration.

This can be used instead of **REGIST** modes 32..39 and 64..71.

This mode operates with the parameters **R_MARK**(channel) , **R_REGPOS**(channel) and **R_ REGISTSPEED**(channel).

If the optional parameters quantity and table_start are used then a set of registration positions can be stored in the table. R_ **REGPOS** will still store the latest registration position.

PARAMETERS:

channel:	This is the registration channel to be used (range 0..7)	
source:	Has no function, set to 0	
edge:	0	rising edge
	1	falling edge
window:	0	no windowing
	1	position must be inside **OPEN_WIN..CLOSE_WIN**
	2	position must be outside **OPEN_WIN..CLOSE_WIN**
quantity	1 - **TSIZE**	Quantity of registration captures to store in the **TABLE**
table_start	0 -**TSIZE**	Start position in the **TABLE** for the registration positions

MODE =22;

SYNTAX:

`REGIST(22, channel, source, edge, window [,quantity, table_start])`

DESCRIPTION:

This mode allows up to 8 hardware registration inputs to be assigned to one axis.

If this mode is used all 8 inputs are assigned to the one axis. You cannot mix **REGIST**(22) and **REGIST**(20) on one bank of inputs.

This mode operates with the parameters **R_MARK**(channel) , **R_REGPOS**(channel) and **R_**

REGISTSPEED(channel).

To use this mode **REG_INPUTS** must be set to $10 before you call the **REGIST** command.

If the optional parameters quantity and table_start are used then a set of registration positions can be stored in the table. R_ **REGPOS** will still store the latest registration position.

PARAMETERS:

channel:	This is the registration channel to be used (range 0..7)	
source:	0	Selects the 24V registration input.
	1	Selects the Z mark.
edge:	0	Rising edge
	1	falling edge
window:	0	no windowing
	1	position must be inside **OPEN_WIN..CLOSE_WIN**
	2	position must be outside **OPEN_WIN..CLOSE_WIN**
quantity	1 - **TSIZE**	Quantity of registration captures to store in the **TABLE**
table_start	0 -**TSIZE**	Start position in the **TABLE** for the registration positions

MODE = 23;

SYNTAX:
REGIST(23)

DESCRIPTION:
This mode assigns a 2.4usec minimum pulse width to the axis. This affects any **REGIST** mode that is used.

The default value is 0.15usec.

MODE = 24:

SYNTAX:
REGIST(24)

DESCRIPTION:
This mode assigns a 0.15usec minimum pulse width to the axis. This affects any **`REGIST`** mode that is used.

This is the default value.

SEE ALSO:
`MARK, MARKB, R_MARK, REG_POS, REG_POSB, R_REGPOS, REGIST_SPEED, REGIST_SPEEDB, R_REGISTSPEED, REGIST_DELAY, REG_INPUTS`

REGIST_CONTROL

TYPE:
Reserved Keyword

DESCRIPTION:
Read or set the low level bit pattern in the control register

REGIST_DELAY

TYPE:
Axis Parameter

DESCRIPTION:
The value, in milliseconds, of the total system delays between a signal appearing on the registration input and the position being available to the time-based registration algorithm. A digital system will usually transfer the actual position information with a one servo period delay. Therefore the **`REGIST_DELAY`** must be adjusted when the **`SERVO_PERIOD`** parameter is not at the default value.

In most real-world systems there are delays built into the registration circuit; the external sensor and the input opto-isolator will have some fixed response time. As machine speed increases, the fixed electrical delays will have an effect on the captured registration position. **`REGIST_DELAY`** can be adjusted to take account of the total delays due to the servo period and input.

VALUE:
The total registration delay in milliseconds

EXAMPLES:

EXAMPLE 1:

Compensate for fixed delay of one servo period plus 10 microseconds sensor input delay when **SERVO_PERIOD** is 1000.

```
    REGIST_DELAY = -1.01
```

EXAMPLE 2:

Compensate for fixed delay of one servo period plus 15 microseconds sensor input delay when **SERVO_PERIOD** is 500.

```
    REGIST_DELAY = -0.515
```

EXAMPLE 3:

Compensate for fixed delay of one servo period plus 10 microseconds sensor input delay plus one additional SLM cycle of 125 microseconds.

```
    REGIST_DELAY = -1.135
```

REGIST_SPEED

TYPE:

Axis Parameter (Read Only)

DESCRIPTION:

Stores the speed of the axis when a registration mark was seen user units per milli-second. This parameter is used with the first (A) hardware registration channel, or Z mark only.

In most real-world systems there are delays built into the registration circuit; the external sensor and the input opto-isolator will have some fixed response time. As machine speed increases, the fixed electrical delays will have an effect on the captured registration position.

REGIST_SPEED returns the value of axis speed captured at the same time as **REG_POS**. The captured speed and position values can be used to calculate a registration position that does not vary with speed because of the fixed delays.

Value:

The speed of the axis in user units per milli-second at which the registration event occurred.

This parameter has the units of user_units/msec at all **SERVO_PERIOD** settings.

EXAMPLE:

Compensate for fixed delays in the registration circuit using **REGIST_SPEED**.

fixed_delays=0.020 ‘ circuit delays in milliseconds

```
    REGIST(20, 0, 0, 0, 0)
    WAIT UNTIL MARK
    captured_position = REG_POS-(REGIST_SPEED*fixed_delays)
```

SEE ALSO:

REGIST, REGIST_SPEEDB, R_REGISTSPEED

REGIST_SPEEDB

TYPE:

Axis Parameter (Read Only)

DESCRIPTION:

Stores the speed of the axis when a registration mark was seen user units per milli-second. This parameter is used with the second (B) hardware registration channel, or Z mark only.

In most real-world systems there are delays built into the registration circuit; the external sensor and the input opto-isolator will have some fixed response time. As machine speed increases, the fixed electrical delays will have an effect on the captured registration position.

REGIST_SPEEDB returns the value of axis speed captured at the same time as **REG_POSB**. The captured speed and position values can be used to calculate a registration position that does not vary with speed because of the fixed delays.

VALUE:

The speed of the axis in user units per milli-second at which the registration event occurred.

This parameter has the units of **UNITS**/msec at all **SERVO_PERIOD** settings.

SEE ALSO:

REGIST, REGIST_SPEED, R_REGISTSPEED

REMAIN

TYPE:

Axis Parameter (Read Only)

DESCRIPTION:

This is the distance, in **UNITS**, remaining to the end of the current move. It may be tested to see what amount of the move has been completed.

VALUE:

The distance remaining in user **UNITS** of the current move

EXAMPLE:

To change the speed to a slower value 5mm from the end of a move.

```
    start:
      SPEED=10
      MOVE(45)
      WAIT UNTIL REMAIN<5
      SPEED=1
      WAIT IDLE
```

REMOTE

TYPE:

System Command

SYNTAX:

`REMOTE(slot)`

DESCRIPTION:

Starts up the **REMOTE_PROGRAM** communication protocol as a program which communicates with PCMotion ActiveX. The **REMOTE** program will take up a user process if it is run automatically or manually. It is recommended that **REMOTE** should run on a high priority process, **REMOTE_PROC** can be set to define which process the **REMOTE_PROGRAM** runs on.

The **REMOTE** program is normally started automatically when you open a PC*Motion* connection. You can call it manually if you wish to control the starting of the process manually.

If you execute **REMOTE** manually the program it runs in will suspend at the **REMOTE** line. The **REMOTE** therefore should be the last line of the program to execute.

PARAMETERS:

slot:	0

EXAMPLE:

A program that will start the **REMOTE** program on process 20 if the project wants to run in debug mode.

```
  WHILE(1)
```

```
    IF VR(debug)=TRUE THEN
      REMOTE(0)
    ELSE
      WA(100)
    ENDIF
  WEND
```

SEE ALSO:

REMOTE_PROC

REMOTE_PROC

TYPE:

System Parameter (**MC_CONFIG** / **FLASH**)

DESCRIPTION:

When the TrioPC ActiveX opens a synchronous connection to the *Motion Coordinator*, the **REMOTE_PROGRAM** is started on the highest available process. **REMOTE_PROC** can be set to specify a different process for the **REMOTE_PROGRAM**. If the defined process is in use then the next lower available process will be used.

REMOTE_PROC is stored in Flash EPROM and can also be set in the MC_**CONFIG** script file.

VALUE:

-1	Use the highest available process (default)
0 to max process	Run on defined process

EXAMPLES:

EXAMPLE1:

Set **REMOTE_PROGRAM** to start on process 19 or lower (using the command line terminal).

```
>>REMOTE_PROC=19
>>
```

EXAMPLE2:

Remove the **REMOTE_PROC** setting so that **REMOTE_PROGRAM** starts on default process (using **MC_CONFIG**).

```
 'MC_CONFIG script file
REMOTE_PROC = -1  'Start on default process on connection
```

SEE ALSO:
`REMOTE`

RENAME

TYPE:
System Command

SYNTAX:
`RENAME oldname newname`

DESCRIPTION:
Renames a program in the *Motion Coordinator* directory.

It is not normally used except by *Motion* Perfect.

PARAMETERS:

oldname:	The name of the program to rename.
newname:	The new name of the program.

EXAMPLE:
```
    >>RENAME car voiture
    OK
    >>
```

REP_DIST

TYPE:
Axis Parameter

DESCRIPTION:
The repeat distance contains the allowable range of movement for an axis before the position count overflows or underflows.

When **`MPOS`** and **`DPOS`** reach **`REP_DIST`** they will wrap to either 0 or -**`REP_DIST`** depending on **`REP_OPTION`**. The same applies in reverse so when **`MPOS`** and **`DPOS`** reach either 0 or -**`REP_DIST`** they wrap to **`REP_DIST`**.

By default **REP_DIST** is less than the software limits. If you increase **REP_DIST** from the default value you may accidently activate **FS_LIMIT** or **RS_LIMIT**.

If a position is outside **REP_DIST** then it is adjusted by **REP_DIST** every **SERVO_PERIOD**, until the position is within **REP_DIST**. It is recommended to set the position within **REP_DIST** using **DEFPOS** or **OFFPOS** before setting **REP_DIST**.

VALUE:

The position in user units where the axis position wraps.

EXAMPLES:

EXAMPLE 1:

Units are set so that an axis units is degrees. The programmer wants to work in the range 1-360, which requires **REP_OPTION**=1.

```
REP_OPTION=1
DEFPOS(0)
REP_DIST=360
```

EXAMPLE 2:

MOVETANG requires the axis to be configures so it pi radians of the full revolution. For a 4000 count per rev encoder this means between -2000 and 2000. This can be configured as follows

```
BASE(0)
UNITS=1
DEFPOS(0)
REP_OPTION=0
REP_DIST=2000
MOVETANG(0,1)
```

SEE ALSO:

FS_LIMIT, RS_LIMIT

REP_OPTION

TYPE:

Axis Parameter

DESCRIPTION:

REP_OPTION allows different repeat options for the axis. It can be used to affect the way the position of an axis wraps or the repeating mode of **CAMBOX**, **MOVELINK** and **FLEXLINK**.

VALUE:

Bit	Description		Value
0	0	Axis position range is -**REP_DIST** to +**REP_DIST**	1
	1	Axis position range is 0 to +**REP_DIST**	
1	0	Automatic repeat option is disabled	2
	1	Disable the automatic repeat option of **CAMBOX** and **MOVELINK**	
2	0	**REP_DIST**, **DEFPOS** and **OFFPOS** will affect **MPOS** and **DPOS**	4
	1	**REP_DIST**, **DEFPOS** and **OFFPOS** will affect **MPOS** only	
3	0	**FRAME_REP_DIST** is disabled	8
	1	This mode is to be used with **FRAME** and **USER_FRAME** only and has the following functionality: **REP_DIST** is disabled **FRAME_REP_DIST** is used when **FRAME** <> 0 or **USER_FRAME** <> 0 **FRAME_REP_DIST** will only change **DPOS** and **WORLD_DPOS** **DATUM**, **DEFPOS** and **OFFPOS** only work when **FRAME** = 0 and **USER_FRAME**(0)	

Bit 2 has been included for backward compatibility, it is not recommended to use this on new applications.

EXAMPLES:

EXAMPLE 1:

An axis has 400 counts per revolution, configure **REP_DIST** and **REP_OPTION** so that it wraps from 0 to 4000.

```
    REP_OPTION = 1
    REP_DIST = 4000
```

EXAMPLE 2:

A program is running a continuous **MOVELINK**, when an input is triggered the link must end at the end of the next cycle. Set bit is used so not to clear any other bits that may be active.

```
    MOVELINK((1, 1.6, 0.6, 0.6, 1, 4)
    WAIT UNTIL IN(1) = ON
    REP_OPTION = REP_OPTION AND 2
```

SEE ALSO:

CAMBOX, FRAME_REP_DIST, MOVELINK, REP_DIST

REPEAT.. UNTIL

TYPE:
Program Structure

SYNTAX:
```
REPEAT
  commands
UNTIL expression
```

DESCRIPTION:
The **REPEAT**..**UNTIL** construct allows a block of commands to be continuously repeated until an expression becomes **TRUE**. **REPEAT**..**UNTIL** loops can be nested without limit.

The commands inside a **REPEAT**..**UNTIL** structure will always be executed at least once, if you want them to only be executed on the expression you can use a **WHILE**..**WEND**.

PARAMETERS:

expression:	Any valid TrioBASIC expression
commands:	TrioBASIC statements that you wish to execute

EXAMPLE:
A conveyor is to index 100mm at a speed of 1000mm/s wait for 0.5s and then repeat the cycle until an external counter signals to stop by setting input 4 on.
```
SPEED=1000
REPEAT
  MOVE(100)
  WAIT IDLE
  WA(500)
UNTIL IN(4)=ON
```

RESET

TYPE:
Process Command

SYNTAX:
```
RESET
```

DESCRIPTION:
Sets the value of all the local named variables of a TrioBASIC process to 0.

EXAMPLE:
As part of an error recovery routine **RESET** can be used to clear all local variables before they are initialised again

```
    WDOG=OFF
    DATUM(0)   'reset error
    RESET      'clear local variables
    counter = 0
    error_number =0
```

REV_IN

TYPE:
Axis Parameter

DESCRIPTION:
This parameter holds the input number to be used as a reverse limit input.

When the reverse limit input is active any motion on that axis is **CANCELed**.

When **REV_IN** is active **AXISSTATUS** bit 5 is set.

The input used for **REV_IN** is active low.

When the reverse limit input is active the controller will cancel the move, so the axis will decelerate at **DECEL** or **FASTDEC**.

VALUE:

-1	disable the input as **REV_IN** (default)
0-63	Input to use as the reverse input switch

Any type of input can be used, built in, Trio CAN I/O, CANopen or virtual.

EXAMPLE:
Set up inputs 8 and 9 as forward and reverse limit switches for axis 4.

```
    BASE(4)
    FWD_IN = 8
    REV_IN = 9
```

SEE ALSO:

FWD_IN, **FS_LIMIT**, **RS_LIMIT**

REV_JOG

TYPE:

Axis Parameter

DESCRIPTION:

This parameter holds the input number to be used as a jog reverse input.

When the **REV_JOG** input is active the axis moves in reverse at **JOGSPEED**.

The input used for **REV_IN** is active low.

It is advisable to use **INVERT_IN** on the input for **REV_JOG** so that 0V at the input disables the jog.

FWD_JOG overrides **REV_JOG** if both are active

VALUE:

-1	disable the input as **REV_JOG** (default)
0-63	Input to use as datum input

EXAMPLE:

Initialise the **REV_JOG** so that it is active high on input 12

```
    INVERT_IN(12,ON)
    FWD_JOG=12
```

REVERSE

TYPE:

Axis Command

SYNTAX:

REVERSE

ALTERNATE FORMAT:

RE

DESCRIPTION:

Sets continuous reverse movement. The axis accelerates at the programmed **ACCEL** rate and continues moving at the **SPEED** value until either a **CANCEL** or **RAPIDSTOP** command are encountered. It then decelerates to a stop at the programmed **DECEL** rate.

If the axis reaches either the reverse limit switch or reverse soft limit, the **REVERSE** will be cancelled and the axis will decelerate to a stop.

EXAMPLES:

EXAMPLE 1:

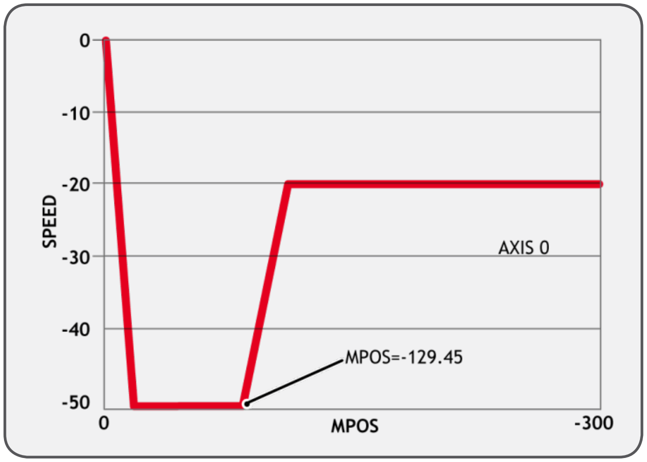
Run an axis in reverse. When an input signal is detected on input 5, stop the axis.

back:

```
    REVERSE
    'Wait for stop signal:
    WAIT UNTIL IN(5)=ON
    CANCEL
    WAIT IDLE
```

EXAMPLE 2:

Run an axis in reverse. When it reaches a certain position, slow down.

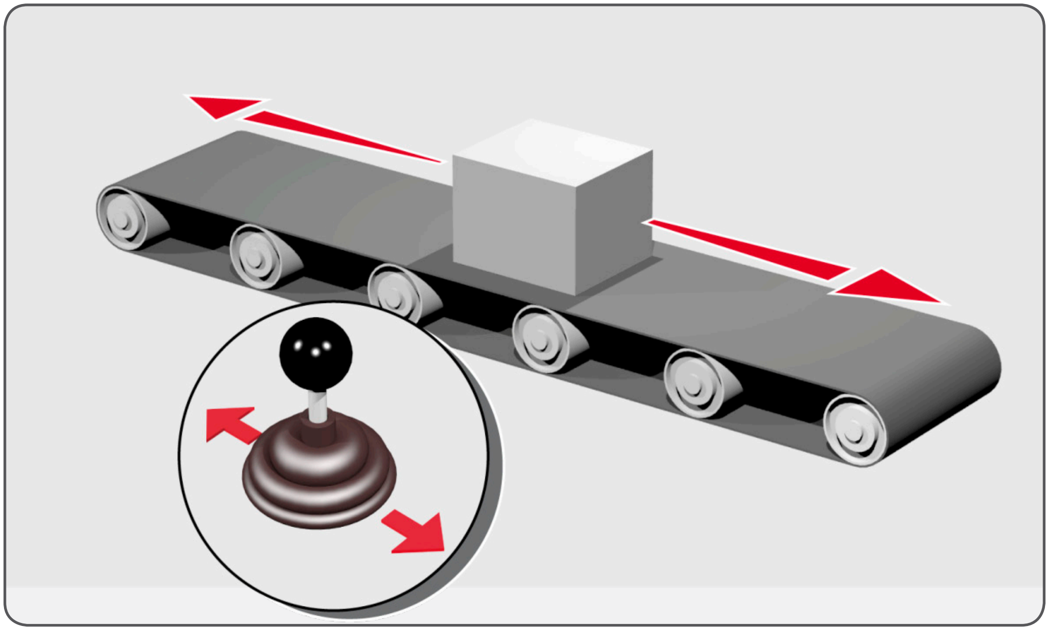


```
    DEFPOS(0)        'set starting position to zero
    REVERSE
    WAIT UNTIL MPOS<-129.45
```

```
SPEED=slow_speed
WAIT UNTIL VP_SPEED=slow_speed 'wait until the axis slows
OP(11,ON)  'turn on an output to show that speed is now slow
```

EXAMPLE 3:

A joystick is used to control the speed of a platform. A dead-band is required to prevent oscillations from the joystick midpoint. This is achieved through setting reverse, which sets the correct direction relative to the operator, the joystick then adjusts the speed through analogue input 0.



```
REVERSE
WHILE IN(2)=ON
  IF AIN(0)<50 AND AIN(0)>-50 THEN 'sets a dead-band in the input
    SPEED=0
  ELSE
    SPEED=AIN(0)*100   'sets speed to a scale of AIN
  ENDIF
WEND
CANCEL
```

SEE ALSO:

FORWARD

RIGHT

TYPE:
STRING Function

SYNTAX:
`RIGHT(string, length)`

DESCRIPTION:
Returns the right most section of the specified string using the length specified.

PARAMETERS:

string:	String to be used
length:	Length of string to be returned

EXAMPLES:

EXAMPLE 1:
Pre-define a variable of type string and later print its right most 10 characters:

```
    DIM str1 AS STRING(32)
    str1 = "TRIO MOTION TECHNOLOGY"
    PRINT RIGHT(str1, 10)
```

SEE ALSO:
CHR, STR, VAL, LEN, LEFT, MID, LCASE, UCASE, INSTR

RND

TYPE:
Mathematical Function

SYNTAX:
`value = RND(<limit>)`

DESCRIPTION:
The RND function returns a random 32-bit unsigned number between 0 and (limit-1).

PARAMETERS:

limit:	Optional parameter to specify the modular math limit of the random value. The default is hex **$FFFFFFFF**
value:	The random integer number generated

EXAMPLES:

EXAMPLE 1:

Print a random 8-bit number on the command line

```
>>PRINT RND(1<<8)
173
>>PRINT RND(1<<8)
98
>>PRINT RND(1<<8)
225
>>
```

EXAMPLE 2:

Print a random number from 0 to 99 inclusive on the command line

```
>>PRINT RND(100)
61
>>PRINT RND(100)
3
>>PRINT RND(100)
40
>>
```

RS_LIMIT

TYPE:

Axis Parameter

ALTERNATE FORMAT:

RSLIMIT

DESCRIPTION:

An end of travel limit may be set up in software thus allowing the program control of the working envelope of the machine. This parameter holds the absolute position of the forward travel limit in user units.

Bit 10 of the **AXISSTATUS** register is set when the axis position is greater than the **RS_LIMIT**.

When **DPOS** reaches **RS_LIMIT** the controller will cancel the move, so the axis will decelerate at **DECEL** or **FASTDEC**.

RS_LIMIT is disabled when it has a value greater than **REP_DIST**.

VALUE:
The absolute position of the software forward travel limit in user units. (default = 200000000000)

EXAMPLE:
After homing a machine set up the reverse software limit so that the axis will stop 10mm away from the hard stop. So if the hard limit is at -200, with a maximum speed of 400 and a **FASTDEC** of 1000 the reverse limit will be -189.6.

```
hard_limit_position = -200
max_speed = 400
FASTDEC = 1000

DATUM(3)
WAIT IDLE
RS_LIMIT= hard_limit_position + ( max_speed/FASTDEC +10 )
```

SEE ALSO:
FS_LIMIT, FWD_IN, REV_IN

RUN

TYPE:
System Command

SYNTAX:
```
RUN [“program” [, process]]
```

DESCRIPTION:
Runs a named program on the controller. Programs can be RUN from another program.

A program can be run multiple times in different processes. You can use **PROCNUMBER** to help assign values in the program.

Programs will continue to execute until there are no more lines to execute, a **HALT** is typed in the command line, a **STOP** is issued or there is a run time error.

PARAMETERS:

program:	Name of program to be run. If not present the **SELECTed** program is run
process:	Optional process number. (default highest available)

EXAMPLES:

EXAMPLE 1:
`SELECT` the program `STARTUP` and run it on he command line.

```
>>SELECT "STARTUP"
STARTUP selected
>>RUN%[Process 21:Program STARTUP] - Running
>>%[Process 21:Line 238] (31) - Program is stopped
>>
```

EXAMPLE 2:
From the `MAIN` program, run the `STARTUP` program on process 2 and wait for its completion:

```
RUN "STARTUP", 2
WAIT UNTIL PROC_STATUS PROC(2) <> 0   'wait for program to start
WAIT UNTIL PROC_STATUS PROC(2) = 0    'wait for program to complete
WDOG=ON
```

EXAMPLE 3:
After `STARTUP` has completed the `MAIN` program will start other programs running in the highest available processes.

```
RUN "IO_CONTROL"
RUN "HMI"
RUN "SAUSAGE_CHOPPER"
```

SEE ALSO:
HALT , PROCNUMBER, RUN_ERROR, SELECT, STOP

RUN_ERROR

TYPE:
Process Parameter

DESCRIPTION:
Contains the number of the last run time error that stopped the program on the specified process.

`RUN_ERROR` = 31 is a normal completion of a program.

VALUE:

Value:	Description:
1	Command not recognized
2	Invalid transfer type
3	Error programming Flash
4	Operand expected
5	Assignment expected
6	**QUOTES** expected
7	Stack overflow
8	Too many variables
9	Divide by zero
10	Extra characters at end of line
11	] expected in **PRINT**
12	Cannot modify a special program
13	**THEN** expected in IF/**ELSEIF**
14	Error erasing Flash
15	Start of expression expected
16	) expected
17	, expected
18	Command line broken by ESC
19	Parameter out of range
20	No process available
21	Value is read only
22	Modifier not allowed
23	Remote axis is in use
24	Command is command line only
25	Command is runtime only
26	**LABEL** expected

Value:	Description:
27	Program not found
28	Duplicate Identifier
29	Program is locked
30	Program(s) running
31	Program is stopped
32	Cannot select program
33	No program selected
34	No more programs available
35	Out of memory
36	No code available to run
37	Command out of context
38	Too many nested structures
39	Structure nesting error
40	**ELSE**/**ELSEIF**/**ENDIF** without previous IF
41	**WEND** without previous **WHILE**
42	**UNTIL** without previous **REPEAT**
43	Identifier expected
44	TO expected after FOR
45	Too may nested FOR/**NEXT**
46	**NEXT** without FOR
47	**UNTIL**/**IDLE** expected after **WAIT**
48	**GOTO**/**GOSUB** expected
49	Too many nested **GOSUB**
50	**RETURN** without **GOSUB**
51	**LABEL** must be at start of line
52	Cannot nest one line IF
53	**LABEL** not found

Value:	Description:
54	**LINE NUMBER** cannot have decimal point
55	Cannot have multiple instances of **REMOTE**
56	Invalid use of $
57	VR(x) expected
58	Program already exists
59	Process already selected
60	Duplicate axes not permitted
61	PLC type is invalid
62	Evaluation error
63	Reserved keyword not available on this controller
64	**VARIABLE** not found
65	Table index range error
66	Features enabled do not allow **ATYPE** change
67	Invalid line number
68	String exceeds permitted length
69	Scope period should exceed number of Ain params
70	Value is incorrect
71	Invalid I/O channel
72	Value cannot be set. Use **CLEAR_PARAMS** command
73	Directory not locked
74	Directory already locked
75	Program not running on this process
76	Program not running
77	Program not paused on this process
78	Program not paused
79	Command not allowed when running *Motion* Perfect
80	Directory structure invalid

Value:	Description:
81	Directory is **LOCKED**
82	Cannot edit program
83	Too many nested **OPERANDS**
84	Cannot reset when drive servo on
85	Flash Stick Blank
86	Flash Stick not available on this controller
87	Slave error
88	Master error
89	Network timeout
90	Network protocol error
91	Global definition is different
92	Invalid program name
93	Program corrupt
94	More than one program running when trying to set **GLOBAL**/**CONSTANT**
95	Program encrypted
96	**BASIC TOKEN** definition incorrect
97	(expected
98	Number expected
99	AS expected
100	**STRING**, **VECTOR** or **ARRAY** expected
101	String expected
102	Download Abort or Timeout
103	Cannot specify program type for an existing program
104	File error: Invalid **COFF** image file
105	Variable defined outside include file
106	Command not allowed within **INCLUDE** file
107	Serial Number must be -1

Value:	**Description:**
108	Append block inconsistent
109	Invalid range specified
110	Too many items defined for block
111	Invalid `MSPHERICAL` input
112	Too many labels
113	Symbol table locked
114	Incorrect symbol type
115	Variables not permitted on Command Line
116	Invalid program type
117	Parameter expected
118	Firmware error: Device in use
119	Device error: Timeout waiting for device
120	Device error: Command not supported by device
121	Device error: CRC error
122	Device error: Error writing to device
123	Device error: Invalid response from device
124	Firmware error: Cannot reference data outside current block
125	Disk error: Invalid MBR
126	Disk error: Invalid boot sector
127	Disk error: Invalid sector/cluster reference
128	File error: Disk full
129	File error: File not found
130	File error: Filename already exists
131	File error: Invalid filename
132	File error: Directory full
133	Command only allowed when running *Motion* Perfect
134	# expected

Value:	Description:
135	FOR expected
136	**INPUT**/**OUTPUT**/**APPEND**/**FIFO_READ**/**FIFO_WRITE** expected
137	File not open
138	End of file
139	File already open
140	Invalid storage area
141	Numerical error: Invalid Floating-Point operation
142	Invalid System Code - wrong controller
143	IEC error: invalid variable access
144	Numerical error: Not-a-Number(NaN) used
145	Numerical error: Infinity used
146	Numerical error: Subnormal value used
147	MAC EEPROM is locked
148	Invalid mix of data types
149	Invalid startup configuration command
150	Symbol is not a variable
151	Robot Features are NOT enabled (FEC 22)
152	IEC runtime limited to 1 hour (FEC 21)
153	Command not allowed with current **ATYPE**
154	Wildcard length must be 1
155	Incompatible array dimensions
156	Matrix is singular
157	Program is not an executable type
158	Disk error: Format must be FAT32
159	Program is stopped (**HALT FORCED**)

EXAMPLE:

Use the command line to check why a program that was running on process 5 has stopped. The result of 9 indicates a divide by zero error.

```
>>? RUN_ERROR PROC(5)
9.0000
>>
```

RUNTYPE

TYPE:
System Command

SYNTAX:
`RUNTYPE "program", mode [,process]`

DESCRIPTION:
Sets if program is run automatically at power up, and which process it is to run on.

The current status of each program's **RUNTYPE** is displayed when a **DIR** command is performed.

For any program to run automatically on power-up ALL the programs on the controller must compile without errors. Even if they are not used.

Usually a programs **RUNTYPE** is set through *Motion* Perfect. It can be useful to set the **RUNTYPE** when loading programs from a SD card.

PARAMETERS:

program:	The program to set the power up mode.	
mode:	1	Run automatically on power up.
	0	Manual running.
process:	The process number to run the program on.	

EXAMPLE:
When loading a sequence of programs from a SD card, **MAIN** must be set to run from power up and HMI must be run on process 4 on power up. The following is from the **TRIOINIT**.bas file.

```
FILE "LOAD_PROGRAM" "MOTION"
FILE "LOAD_PROGRAM" "HMI"
FILE "LOAD_PROGRAM" "MAIN"
RUNTYPE "HMI", 1, 4
RUNTYPE "MAIN", 1
```

```
AUTORUN
```

S_REF

TYPE:
Axis Parameter

DESCRIPTION:
`S_REF` is identical to DAC.

SEE ALSO:
`DAC`

S_REF_OUT

TYPE:
Axis Parameter

DESCRIPTION:
`S_REF_OUT` is identical to **`DAC_OUT`**.

SEE ALSO:
`DAC_OUT`

SCHEDULE_OFFSET

TYPE:
System Parameter

SCHEDULE_TYPE

TYPE:
System Parameter (**`MC_CONFIG`** / **`FLASH`**)

DESCRIPTION:
This parameter changes the multi-tasking scheduling used when running programs.

Bit 0 disables the scheduling algorithm that allows another program to run while the scheduled program is in a sleep state. A sleep state can be started through a pause in the program using, for example, **`WAIT`** or WA.

When bit 1 is set and **SERVO_PERIOD** is 2000, the firmware doubles the number of interrupts per servo cycle. This should be used in the MC464 when **SERVO_PERIOD** is set to 2000 usec and faster communications is required. The system process can then handshake with the communications processor every millisecond.

The value is saved in Flash memory and can be included in the **MC_CONFIG** script.

VALUE:

Bit	Operation		Value
0	0	Use new scheduling algorithm to make best use of CPU time e.g. any program executing a WA command will not be available for execution again until the WA period is complete (default)	
	1	Revert to old style scheduling such that any active process will execute even when executing a WA command for example. This setting should only be used when upgrading projects from older controllers and the scheduling system causes problems with the program timings.	1
1	0	Use standard process scheduling at 2000 usec servo period.	
	1	When **SERVO_PERIOD** is set to 2000, schedule double processes. In the MC464 this enables communications like DeviceNet to run at the same rate as it does with shorter servo periods. (V2.0209 and later)	2

SCOPE

TYPE:
System Command

SYNTAX:
```
SCOPE(enable, [period, table_start, table_stop, p0 [,p1[,p2 [,p3 [,p4 [,p5
[,p6 [,p7]]]]]]]])
```

DESCRIPTION:
The **SCOPE** command enables capture of up to 4 parameters every sample period. Samples are taken until the table range is filled. Trigger is used to start the capture.

The **SCOPE** facility is a "one-shot" and needs to be re-started by the **TRIGGER** command each time an update of the samples is required.

Make sure to assign the table range outside of any table data used by your programs.

It is normal to use *Motion* Perfect to assign the **SCOPE** command, but it is sometimes useful to do it manually. The table data can be read back to a PC and displayed on the *Motion* Perfect Oscilloscope, saved using *Motion* Perfect or **STICK_WRITE**.

PARAMETERS:

enable:	1 or ON	Enable software **SCOPE** (requires at least 5 parameters)
	0 or OFF	Disable **SCOPE**
period:	The number of servo periods between data samples	
table_start:	Position to start to store the data in the table array	
table_stop:	End of table range to use	
p0:	First parameter to store	
p1:	Second parameter to store	
p2:	Third parameter to store	
p3:	Fourth parameter to store	
p4	Fifth parameter to store	
p5	Sixth parameter to store	
p6	Seventh parameter to store	
p7	Eighth parameter to store	

EXAMPLES:

EXAMPLE 1:

This example arms the **SCOPE** to store the **MPOS** and **DPOS** on axis 5 axis 5 every 10 milliseconds (**SERVO_PERIOD** = 1000). The **MPOS** will be stored in table values 0..499, the **DPOS** in table values 500 to 999. The sampling does not start until the **TRIGGER** command is executed.

```
SCOPE(ON,10,0,1000,MPOS AXIS(5), DPOS AXIS(5))
```

EXAMPLE 2:

Disable the **SCOPE** to prevent **TRIGGER** from starting a capture

```
SCOPE(OFF)
```

SEE ALSO:

TRIGGER

SCOPE_POS

TYPE:
System Parameter (Read Only)

DESCRIPTION:
Returns the current **`TABLE`** index position where the **`SCOPE`** function is currently storing its data.

VALUE:
The table position that is currently being used

SELECT

TYPE:
System Command

SYNTAX:
`SELECT “program”`

DESCRIPTION:
Makes the named program the currently selected program, if the named program does not exist then it makes a program of that name.

It is not normally used except by *Motion* Perfect.

The **`SELECTed`** program cannot be changed when programs are running.

When a program is **`SELECTed`** any previously selected program is compiled.

SERCOS

TYPE:
System Function

SYNTAX:
`sercos (function#,slot,{parameters})`

Description:

This function allows the sercos ring to be controlled from the TrioBASIC programming system. A sercos ring consists of a single master and 1 or more slaves daisy-chained together using fibre-optic cable. During initialisation the ring passes through several 'communication phases' before entering the final cyclic deterministic phase in which motion control is possible. In the final phase, the master transmits control information and the slaves transmit status feedback information every cycle time.

Once the sercos ring is running in CP4, the standard TrioBASIC motion commands can be used.

The *Motion Coordinator* sercos hardware uses the Sercon 816 sercos interface chip which allows connection speeds up to 16Mhz. This chip can be programmed at a register level using the sercos command if necessary. To program in this way it is necessary to obtain a copy of the chip data sheet.

The sercos command provides access to 10 separate functions:

PARAMETERS:

function:	0	Read sercos **`ASIC`**
	1	Write sercos **`ASIC`**
	2	Initialise command
	3	Link sercos drive to Axis
	4	Read parameter
	5	Write parameters
	6	Run sercos procedure command
	7	Check for dirve present
	8	Print network parameter
	9	Reserved
	10	sercos ring status
slot:	The slot number is in the range 0 to 6 and specifies the master module location.	

FUNCTION = 0:

SYNTAX:

`sercos (0, slot, ram/reg, address)`

DESCRIPTION:

This function reads a value from the sercos **`ASIC`**.

Do not use this function without referencing the Sercon 816 data sheet.

PARAMETERS:

slot:	The module slot in which the sercos is fitted.	
ram/reg:	0	read value from RAM
	1	read value from register.
address:	The index address in RAM or register.	

EXAMPLE:
```
    >>?SERCOS(0, 0, 1, $0c)
```

FUNCTION = 1:

SYNTAX:
```
sercos (1, slot, ram/reg, address, value)
```

DESCRIPTION:
This function writes a value to the sercos **ASIC**

Do not use this function without referencing the Sercon 816 data sheet.

PARAMETERS:

slot:	The module slot in which the sercos is fitted.	
ram/reg:	0	write value to RAM
	1	write value to register.
address:	The index address in RAM or register.	
value:	Date to be written	

FUNCTION = 2:

SYNTAX:

```
sercos (2, slot [,intensity [,baudrate [, period]]])
```

DESCRIPTION:

This function initialises the parameters used for communications on the sercos ring.

PARAMETERS:

slot:	The module slot in which the sercos is fitted.
intensity:	Light transmission intensity (1 to 6). Default value is 3.
baudrate:	Communication data rate. Set to 2, 4, 6, 8 or 16.
period:	Sercos cycle time in microseconds. Accepted values are 2000, 1000, 500 and 250usec.

EXAMPLE:

```
    >>SERCOS(2, 3, 4, 16, 500)
```

FUNCTION = 3:

SYNTAX:

```
SERCOS(3, slot, slave_address, axis [, slave_drive_type])
```

DESCRIPTION:

This function links a sercos drive (slave) to an axis.

PARAMETERS:

slot:	The module slot in which the sercos is fitted.
slave_address:	Slave address of drive to be linked to an axis.
axis:	Axis number which will be used to control this drive.

slave_drive_type:	Optional parameter to set the slave drive type. All standard sercos drives require the **GENERIC** setting. The other options below are only required when the drive is using non-standard sercos functions.	
	0	Generic Drive
	1	Sanyo-Denki
	3	Yaskawa + Trio P730
	4	PacSci
	5	Kollmorgen

EXAMPLE:

```
>> sercos (3, 1, 3, 5, 0)  'links drive at address 3 to axis 5
```

FUNCTION = 4:

SYNTAX:

```
sercos (4, slot, slave_address, parameter_ID [, parameter_size[, element_
type [, list_length_offset, [VR_start_index]]])
```

DESCRIPTION:

This function reads a parameter value from a drive

PARAMETERS:

slot:	The module slot in which the sercos is fitted.	
slave_address:	sercos address of drive to be read.	
parameter_ID:	sercos parameter IDN	
parameter_size:	Size of parameter data expected:	
	2	2 byte parameter (default).
	4	4 byte parameter
	6	list of parameter IDs
	7	**ASCII** string

element_type:	sercos element type in the data block:	
	1	ID number
	2	Name
	3	Attribute
	4	Units
	5	Minimum Input value
	6	Maximum Input value
	7	Operational data (default)
list_length_offset:	Optional parameter to offset the list length. For drives that return 2 extra bytes, use -2.	
VR_start_index:	Beginning of **VR** array where list will be stored.	

This function returns the value of 2 and 4 byte parameters but prints lists to the terminal in *Motion* Perfect unless **VR** start index is defined.

EXAMPLE:

```
    >> sercos (4, 0, 5, 140, 7)'request "controller type"
    >> sercos (4, 0, 5, 129) 'request manufacturer class 1 diagnostic
```

FUNCTION = 5:

SYNTAX:

sercos (5, slot , slave_address, parameter_ID, parameter_size, parameter_value [, parameter_value …])

DESCRIPTION:

This function writes one or more parameter values to a drive.

PARAMETERS:

slot:	The module slot in which the sercos is fitted.
slave_address:	sercos address of drive to be written.
parameter_ID:	sercos parameter IDN
parameter_size:	Size of parameter data to be written. 2, 4, or 6.

parameter_value:	Enter one parameter for size 2 and size 4. Enter 2 to 7 parameters for size 6 (list).

EXAMPLE:

```
    >> sercos (5, 1, 7, 2, 2, 1000)      'set sercos cycle time
    >> sercos (5, 0, 2, 16, 6, 51, 130)  'set IDN 16 position feedback
```

FUNCTION = 6:

SYNTAX:

```
sercos (6, slot , slave_address, parameter_ID [, timeout,[command_type]])
```

DESCRIPTION:

This function runs a sercos procedure on a drive.

PARAMETERS:

slot:	The communication slot in which the sercos interface is fitted.	
slave_address:	sercos address of drive.	
parameter_ID:	sercos procedure command IDN.	
timeout:	Optional time out setting (msec).	
command_type:	Optional parameter to define the operation:	
	-1	Run & cancel operation (default value)
	0	Cancel command
	1	Run command

EXAMPLE:

```
    >> sercos (6, 0, 2, 99)  'clear drive errors
```

FUNCTION = 7:

SYNTAX:

```
sercos (7 , slot , slave_address)
```

DESCRIPTION:
This function is used to detect the presence of a drive at a given sercos slave address.

PARAMETERS:

slot:	The module slot in which the sercos interface is fitted.
slave_addr:	sercos address of drive.

Returns 1 if drive detected, -1 if not detected.

EXAMPLE:
```
    IF sercos (7, 2, 3) <0 THEN
      PRINT#5, "Drive 3 on slot 2 not detected"
    END IF
```

FUNCTION = 8:

SYNTAX:
`sercos (8 , slot , required_parameter)`

DESCRIPTION:
This function is used to print a sercos network parameter.

PARAMETERS:

slot:	The module slot in which the sercos is fitted.	
required_parameter:	This function will print the required network parameter, where the possible.	
	0	to print a semi-colon delimited list of 'slave Id, axis number' pairs for the registered network configuration (as defined using function 3). Used in Phase 1: Returns 1 if a drive is detected, 0 if no drive detected.
	1	to print the baud rate (either 2, 4, 6, or 8), and
	2	to print the intensity (a number between 0 and 6).

EXAMPLE:
```
    >>? sercos (8,0, 1 )
```

FUNCTION = 10:

SYNTAX:

```
sercos (10,<slot>)
```

DESCRIPTION:

This function checks whether the fibre optic loop is closed in phase 0. Return value is 1 if network is closed, -1 if it is open, and -2 if there is excessive distortion on the network.

PARAMETERS:

slot:	The module slot in which the sercos is fitted.

EXAMPLE:

```
    >>? sercos (10, 1)
    IF sercos (10, 0) <> 1 THEN
      PRINT "sercos ring is open or distorted"
    END IF
```

SERCOS_PHASE

TYPE:

Slot Parameter

DESCRIPTION:

Sets the phase for the sercos ring in the specified slot.

VALUE:

The sercos phase, range 0-4

EXAMPLES:

EXAMPLE 1:

Set the sercos ring attached to the module in slot 0 to phase 3

```
    SERCOS_PHASE SLOT(0) = 3
```

EXAMPLE 2:

If the sercos phase is 4 in slot 2 then turn on the output

```
    IF SERCOS_PHASE SLOT(2)<>4 THEN
    OP(8,ON)
    ELSE
      OP(8,OFF)
    ENDIF
```

SERIAL_NUMBER

TYPE:
System Parameter (Read only)

DESCRIPTION:
Returns the unique Serial Number of the controller.

EXAMPLE:
For a controller with serial number 00325:

```
    >>PRINT SERIAL_NUMBER
    325.0000
    >>
```

SERVO

TYPE:
Axis Parameter

DESCRIPTION:
On a servo axis this parameter determines whether the axis runs under servo control or open loop. When **SERVO**=OFF the axis hardware will output demand value dependent on the DAC parameter. When **SERVO**=ON the axis hardware will output a demand value dependant on the gain settings and the following error.

VALUE:

ON	closed loop servo control enabled
OFF	closed loop servo control disabled

EXAMPLE:
Enable axis 1 to run under closed loop control and axis 1 as open loop.

```
    SERVO AXIS(0)=ON    'Axis 0 is under servo control
    SERVO AXIS(1)=OFF   'Axis 1 is run open loop
```

SERVO_OFFSET

TYPE:

System Parameter (**MC_CONFIG**)

DESCRIPTION:

This parameter is a low-level scheduling parameter to allow fine tuning of when the cyclic servo activities start executing within the firmware in relation to the synchronization pulse received from controller **FPGA**.

Modification to the default settings of this parameter may be required for certain systems that require more time for data to be collected from relatively slow serial encoders for example.

SERVO_OFFSET is an **MC_CONFIG** parameter, if an entry does not exist within the **MC_CONFIG** file then default settings will be used depending upon the selected **SERVO_PERIOD** but is approximately 25% of this time period. The accepted range of values is from 0 to 75% of **SERVO_PERIOD**.

VALUE:

SERVO_OFFSET is specified in microseconds.

EXAMPLE:

```
 ' MC_CONFIG script file
SERVO_PERIOD=1000 ' this value is used for this cycle
SERVO_OFFSET=400  ' this value is used for this cycle
```

SEE ALSO:

SERVO_PERIOD

SERVO_PERIOD

TYPE:

System Parameter (**MC_CONFIG** / **FLASH**)

DESCRIPTION:

This parameter allows the controller servo period to be read or specified. This is the cycle time in which the target position updated and if applicable any positions are read and closed loop calculations performed.

SERVO_PERIOD is a flash parameter and so should be set using the **MC_CONFIG** file.

When the servo period is reduced the maximum number of axes (including virtual) is reduced as per the following table.

`SERVO_PERIOD`	Maximum axes
125us	8
250us	16
500us	32
1000us	64
2000us	64

VALUE:

`SERVO_PERIOD` is specified in microseconds. Only the values 2000, 1000, 500, 250 or 125 usec may be used and the *Motion Coordinator* must be reset before the new servo period will be applied.

The axis count will be limited as the **`SERVO_PERIOD`** is reduced. Normally the headline number of axes can be used when **`SERVO_PERIOD`** is set to 1msec.

EXAMPLES:

EXAMPLE 1:

‘ check controller servo_period on startup

```
IF SERVO_PERIOD<>250 THEN
  SERVO_PERIOD=250
  EX
ENDIF
```

EXAMPLE 2:

```
‘ MC_CONFIG script file
SERVO_PERIOD=500 ‘ this is the value set on power up
```

SERVO_READ

TYPE:

Axis Command

SYNTAX:

`SERVO_READ(vr_start, p0[,p1[,p2[,p3[,p4[,p5[,p6[,p7]]]]]]])`

DESCRIPTION:

Provides servo-synchronized access to axis/system parameters. Between 1 and 8 axis/system parameters can be read synchronously on the next servo cycle for consistent data access when required. The data read is stored in successive **`VR`** memory locations commencing from ‘vr_start’.

The values stored are not scaled by **`UNITS`**.

PARAMETERS:

vr_start:	base index of **`VR`** memory to store data read from parameters
p0..p7:	Axis/System parameters to be read

EXAMPLE:

Read **`MPOS`** & FE for axes 0 & 1 and stores in **`VR`** locations 100,101,102 & 103.

```
    SERVO_READ(100, MPOS AXIS(0), FE AXIS(0), MPOS AXIS(1), FE AXIS(1))
```

SET_BIT

TYPE:

Logical and Bitwise Command

SYNTAX:

`SET_BIT(bit, variable)`

DESCRIPTION:

`SET_BIT` can be used to set the value of a single bit within a **`VR`**() variable. All other bits are unchanged.

PARAMETERS:

bit:	The bit number to set, valid range is 0 to 52
variable:	The **`VR`** which to operate on

EXAMPLE:

Set bit 3 of **`VR`**(7)

```
    SET_BIT(3,7)
```

SEE ALSO:

`READ_BIT, CLEAR_BIT`

SET_ENCRYPTION_KEY

TYPE:
System Command

SYNTAX:
`SET_ENCRYPTION_KEY (2, fec31_password, user_security_code)`

DESCRIPTION:
`SET_ENCRYPTION_KEY` is used to write the user security code to the controller. The user security code is required on the controller when loading encrypted projects on that have been encrypted using the user security code method.

Motion Perfect has a tool to set the user security code

PARAMETERS:

fec31_password	The password for feature enable code 31. This can be downloaded from the E-Store or be provided by your distributor
user_security_code	Your secret user defined security code. This must be kept a secret so that other people cannot use your encrypted projects

SEE ALSO:
`VALIDATE_ENCRYPTION_KEY, PROJECT_KEY`

SETCOM

TYPE:
Command

SET PORT PARAMETERS:

SYNTAX:
```
SETCOM(baudrate,databits,stopbits,parity,port[,mode][,variable][,timeout]
[,linetype])
```

DESCRIPTION:
Allows the user to configure the serial port parameters and enable communication protocols.

By default the controller sets the serial ports to 38400 baud, 8 data bits, 1 stop bits and even parity.

Only one instance of Modbus RTU is available for the serial ports. This means that you can only run Modbus on Port 1 OR port 2 NOT both.

PARAMETERS:

baudrate:	1200, 2400, 4800, 9600, 19200, 38400 or 57600	
databits:	7 or 8	
stopbits:	1 or 2	
parity:	0	None
	1	Odd
	2	Even
port:	1, 2, 50 - 56	
mode:	0	XON/XOFF inactive
	1	XON/XOFF active
	4	MODBUS protocol (16 bit Integer)
	5	Hostlink Slave
	6	Hostlink Master
	7	MODBUS protocol (32 bit IEEE floating point)
	8	Reserved mode
	9	MODBUS protocol (32bit long word integers)
variable:	0 = Modbus uses **VR**	
	1 = Modbus uses **TABLE**	
timeout:	Communications timeout (msec). Default is 3	
linetype:	0	4 wire RS485 (Modbus only)
	1	2 wire RS485 (Modbus only)

Descriptions of the port numbers can be found under the # entry

GET PORT PARAMETERS:

SYNTAX:

```
SETCOM(port)
```

DESCRIPTION:

Prints the configuration of the port to the selected output channel (default terminal)

PARAMETERS:

port:	1, 2, 50 - 56

Descriptions of the port numbers can be found under the # entry

EXAMPLES:

EXAMPLE 1:

Set port 1 to 19200 baud, 7 data bits, 2 stop bits even parity and XON/**XOFF** enabled.

```
    SETCOM(19200,7,2,2,1,1)
```

EXAMPLE 2:

Set port 2 (RS485) to 9600 baud, 8 data bits, 1 stop bit no parity and no XON/**XOFF** handshake.

```
    SETCOM(9600,8,1,0,2,0)
```

EXAMPLE 3:

The Modbus protocol is initialised by setting the mode parameter of the **SETCOM** instruction to 4. The **ADDRESS** parameter must also be set before the Modbus protocol is activated.

```
    ADDRESS=1
    SETCOM(19200,8,1,2,2,4)
```

SGN

TYPE:

Mathematical Function

SYNTAX:

```
value = SGN(expression)
```

DESCRIPTION:

The SGN function returns the **SIGN** of a number.

PARAMETERS:

value:	1	Positive non-zero
	0	Zero
	-1	Negative
expression:	Any valid TrioBASIC expression.	

EXAMPLE:
Detect the sign of the number -1.2 using the command line.

```
    >>PRINT SGN(-1.2)
    -1.0000
    >>
```

<< Shift Left

TYPE:
Logical and Bitwise operator

SYNTAX:
`<expression1> << <expression2>`

DESCRIPTION:
The shift left operator, <<, can be used to logically shift left the bits in an integer variable. The value resulting from expression 1 will be shifted left by the count in expression 2. As the bits are shifted, a 0 will be inserted in the right-most bits of the value.

PARAMETERS:

Expression1:	Any valid TrioBASIC expression
Expression2:	Any valid TrioBASIC expression

EXAMPLE:
Shift the bit pattern in **VR**(23) to the left by 8, thus effecting a multiply by 256.

```
    VR(23) = VR(23)<<8
```

SEE ALSO:
`>>_Shift_Right`

>> Shift Right

TYPE:
Logical and Bitwise operator

SYNTAX:
`<expression1> >> <expression2>`

DESCRIPTION:
The shift right operator, >>, can be used to logically shift right the bits in an integer variable. The value resulting from expression 1 will be shifted right by the count in expression 2. As the bits are shifted, a 0 will be inserted in the left-most bits of the value.

PARAMETERS:

Expression1:	Any valid TrioBASIC expression
Expression2:	Any valid TrioBASIC expression

EXAMPLE:
Shift the bit pattern in **AXISSTATUS** to the right by 4, thus putting the “in forward limit” bit in bit 0.

```
    result = AXISSTATUS >> 4
    in_fwd_limit = result AND 1
```

SEE ALSO:
<<_Shift_Left

SIN

TYPE:
Mathematical Function

SYNTAX:
`value = SIN(expression)`

DESCRIPTION:
Returns the **SINE** of an expression. This is valid for any value in expressed in radians.

PARAMETERS:

value:	The **SINE** of the expression in radians
expression:	Any valid TrioBASIC expression.

EXAMPLE:
Print the **SINE** of 0 on the command line

```
>>PRINT SIN(0)
  0.0000
>>
```

SLOT

TYPE:
Modifier

SYNTAX:
SLOT(position)

DESCRIPTION:
When expansion modules are used they are assigned a **SLOT** number depending on their position in the system. The **SLOT** modifier can be used to assign ONE command, function or slot parameter operation to a particular slot

PARAMETERS:

position:	-1	Built in feature
	0 to max_slot	Expansion module

EXAMPLE:
Check for an Anybus-CC module in the holder in slot 1

```
IF COMMSTYPE SLOT(1) = 62 THEN
  PRINT “No Anybus card present”
ENDIF
```

SEE ALSO:
COMMSPOSITION

SLOT_NUMBER

TYPE:
Axis Parameter (Read Only)

DESCRIPTION:
Returns the **SLOT** number where the axis is located. Axis numbers can be allocated to hardware in a flexible way, so the physical location of the axis cannot be found by the **AXIS** number alone. **SLOT_NUMBER** returns the value from the **BASE** axis or if the **AXIS**(number) modifier is used, it returns the **SLOT** associated with that axis.

EXAMPLE:
```
    PRINT SLOT_NUMBER AXIS(12)

    BASE(2)
    axis2_slot = SLOT_NUMBER

    IF SLOT_NUMBER AXIS(0)<>-1 THEN
      PRINT "Warning - Built-in axis configuration incorrect"
      PRINT "Axis 0 expected for this application."
    ENDIF
```

SEE ALSO:
SLOT, AXIS_OFFSET

SLOT(n)_TIME

TYPE:
Startup Parameter (**MC_CONFIG**)

DESCRIPTION:
The processor splits the time available for running system and user processes into 4 chunks. By default the system splits the available time equally into the 4 chunks, the **SLOT0_TIME, SLOT1_TIME, SLOT2_TIME** and **SLOT3_TIME** parameters allow the user to specify different percentages of the time for each slot.

Note that this is the time slots which the multitasking system uses to run the processes and nothing to do with hardware module SLOT numbers.

Out of the four slots, one is a system task only slot and so not used for user programs. The remaining are for fast and standard processes.

Slot #1: Standard task

Slot #2: Fast task

Slot #3: System process

Slot #4: Fast task

When the **SERVO_PERIOD** is 1ms or 2ms these parameters represent how the available time between consecutive servo cycles is divided into 4 slots, the total must be 100% otherwise default settings of 25% will be used.

When the **SERVO_PERIOD** is 500us SLOT0 and SLOT1 represent how the available time between consecutive servo cycles is divided into 2 slots; SLOT2 and SLOT3 represent how the available time between the next pair of consecutive servo cycles is divided into 2 slots. Both SLOT0_TIME+SLOT1_TIME and SLOT2_TIME+SLOT3_TIME must total 100% otherwise default settings of 50% will be used.

When the **SERVO_PERIOD** is less than 500us these parameters are not applicable, 100% of the available time between consecutive servo cycles is given to a single process.

Note that the minimum percentage allowed for any slot is 10%, otherwise all slots will revert to default settings.

EXAMPLES:

EXAMPLE 1 (SERVO_PERIOD=2000):

```
    SLOT0_TIME=40
    SLOT1_TIME=25
    SLOT2_TIME=20
    SLOT3_TIME=15
```

EXAMPLE 2 (SERVO_PERIOD=500):

```
    SLOT0_TIME=60 'SLOT0_TIME+SLOT1_TIME=100
    SLOT1_TIME=40
    SLOT2_TIME=35 'SLOT2_TIME+SLOT3_TIME=100
    SLOT3_TIME=65
```

EXAMPLE 3 (SERVO_PERIOD=1000):

```
    SLOT0_TIME=20
    SLOT1_TIME=30
    SLOT2_TIME=30
    SLOT3_TIME=30
```

'Invalid settings, total > 100% - default settings of 25% will be used

SEE ALSO:

SERVO_PERIOD.

SPEED

TYPE:
Axis Parameter

DESCRIPTION:
The **SPEED** axis parameter can be used to set/read back the demand speed axis parameter.

VALUE:
The axis speed in user **UNITS**

EXAMPLE:
Set the speed and then print it to the user.

```
    SPEED=1000
    PRINT “Speed Set=”;SPEED
```

SPEED_SIGN

TYPE:
Reserved Keyword

SPHERE_CENTRE

TYPE:
Axis Command

SYNTAX:
SPHERE_CENTRE(table_mid, table_end, table_out)

DESCRIPTION:
Returns the co-ordinates of the centre point (x, y, z) of an arc from any mid point (x, y, z) and the end point (x, y, z). X, Y and Z are returned in the **TABLE** memory area and can be printed to the terminal as required. Note that the mid and end positions are relative to the start position.

PARAMETERS:

TABLE mid:	Position in table of mid point x,y,z

TABLE end:	Position in table of end point x,y,z
TABLE out:	Position in table to store the output data: Offset 0 - X Offset 1 - Y Offset 2 - Z Offset 3 - Angle Offset 4 - Radius Offset 5 - Set to 1 if error, 0 otherwise

EXAMPLE:
```
    TABLE(10,-200,400,0)
    TABLE(20,-500,500,0)
    SPHERE_CENTRE(10,20,30)
    x = TABLE(30)
    y = TABLE(31)
    z = TABLE(32)
    ang = TABLE(33)
    rad = TABLE(34)
    err = TABLE(35)
    PRINT x,y,z,ang,rad,err
```

SQR

TYPE:
Mathematical Function

SYNTAX:
```
value = SQR(number)
```

DESCRIPTION:
Returns the square root of a number.

PARAMETERS:

value:	The square root of the number
number:	Any valid TrioBASIC number or variable.

EXAMPLE:
Calculate the square root of 4 using the command line.
```
    >>PRINT SQR(4)
    2.0000
```

```
>>
```

SRAMP

TYPE:
Axis Parameter

DESCRIPTION:
This parameter stores the s-ramp factor. It controls the amount of rounding applied to trapezoidal profiles. **SRAMP** should be set, when a move is not in progress, to a maximum of half the **ACCEL**/**DECEL** time. The setting takes a short while to be applied after changes.

VALUE:
Time between 0..250 milliseconds

SRAMP must be set before a move starts. If for example you change the **SRAMP** from 0 to 200, then start a move within 200 milliseconds the full **SRAMP** setting will not be applied.

EXAMPLE:
To provide smooth transition into the acceleration, an S-ramp is applied with a time of 50msec.

```
    SPEED = 160000
    ACCEL = 1600000
    DECEL = 1600000
    SRAMP = 50

    WA(50)

    MOVEABS(100000)
```

Without the S-ramp factor, the acceleration takes 100 msec to reach the set speed. With **SRAMP**=50, the acceleration takes 150 msec but the rate of change of force (torque) is controlled. i.e. Jerk is limited.

START_DIR_LAST

TYPE:
Axis Parameter (Read Only)

DESCRIPTION:

Returns the direction of the start of the last loaded interpolated motion command. **START_DIR_LAST** will be the same as **END_DIR_LAST** except in the case of circular moves.

This parameter is only available when using **SP** motion commands such as **MOVESP**, **MOVEABSSP** etc.

VALUE:

End direction, in radians between -PI and PI. Value is always positive.

EXAMPLE:

Run two moves the first starting at a direction of 45 degrees and the second 0 degrees.

```
>>MOVESP(10000,10000)
>>? START_DIR_LAST
0.7854
>>MOVESP(0,10000)
>>? START_DIR_LAST
0.0000
>>
```

SEE ALSO:

CHANGE_DIR_LAST, END_DIR_LAST

STARTMOVE_SPEED

TYPE:

Axis Parameter

DESCRIPTION:

This parameter sets the start speed for a motion command that support the advanced speed control (commands ending in SP). The **VP_SPEED** will decelerate until **STARTMOVE_SPEED** is reached for the start of the motion command.

The lowest value of **SPEED**, **ENDMOVE_SPEED**, **FORCE_SPEED** or **STARTMOVE_SPEED** will take priority.

STARTMOVE_SPEED is loaded into the buffer at the same time as the move so you can set different speeds for subsequent moves.

In general **STARTMOVE_SPEED** is only used by the **CORNER_MODE** methods. The user can program all profiles using only **FORCE_SPEED** and **ENDMOVE_SPEED**.

VALUE:
The speed at which the SP motion command will start, in user **UNITS**. (default 0)

SEE ALSO:
FORCE_SPEED, ENDMOVE_SPEED, CORNER_MODE

STEP_RATIO

TYPE:
Axis Command

SYNTAX:
`STEP_RATIO(output_count, dpos_count)`

DESCRIPTION:
This command sets up an integer ratio for the axis' stepper output. Every servo-period the number of steps is passed through the step_ratio function before it goes to the step pulse output.

The **STEP_RATIO** function operates before the divide by 16 factor in the stepper axis. This maintains the good timing resolution of the stepper output circuit.

STEP_RATIO does not replace **UNITS**. Do not use **STEP_RATIO** to remove the x16 factor on the stepper axis as this will lead to poor step frequency control.

PARAMETERS:

output_count:	Number of counts to output for the given dpos_count value. Range: 0 to 16777215.
dpos_count:	Change in **DPOS** value for corresponding output count. Range: 0 to 16777215.

Large ratios should be avoided as they will lead to either loss of resolution or much reduced smoothness in the motion. The actual physical step size x 16 is the basic resolution of the axis and use of this command may reduce the ability of the *Motion Coordinator* to accurately achieve all positions.

EXAMPLES:

EXAMPLE 1:
Two axes are set up as X and Y but the axes' steps per mm are not the same. Interpolated moves require identical **UNITS** values on both axes in order to keep the path speed constant and for **MOVECIRC** to work correctly. The axis with the lower resolution is changed to match the higher step resolution axis so as to maintain the best accuracy for both axes.

```
    'Axis 0: 500 counts per mm (31.25 steps per mm)
    'Axis 1: 800 counts per mm (50.00 steps per mm)

    BASE(0)
    STEP_RATIO(500,800)
    UNITS = 800
    BASE(1)
    UNITS = 800
```

EXAMPLE 2:

A stepper motor has 400 steps per revolution and the installation requires that it is controlled in degrees. As there are 360 degrees in one revolution, it would be better from the programmer's point of view if there are 360 counts per revolution.

```
    BASE(2)
    STEP_RATIO(400, 360)
    'Note: this has reduced resolution of the stepper axis
    MOVE(360*16) 'move 1 revolution
```

EXAMPLE 3:

Remove the step ratio from an axis.

```
    BASE(0)
    STEP_RATIO(1, 1)
```

STEPLINE

TYPE:

System Command

SYNTAX:

`STEPLINE ["program" ,[process]]`

DESCRIPTION:

Steps one line in a program. This command is used by *Motion* Perfect to control program stepping. It can also be entered directly from the command line or as a line in a program with the following parameters.

All copies of this named program will step unless the process number is also specified.

If the program is not running it will step to the first executable line on either the specified process or the next available process if the next parameter is omitted.

If the program name is not supplied, either the `SELECTed` program will step (if command line entry) or the program with the `STEPLINE` in it will stop running and begin stepping.

PARAMETERS:

program:	This specifies the program to be stepped.
process:	Specifies the process number.

EXAMPLE:
Start the program conveyor running in the highest available process by stepping into the first executable line.

```
>>STEPLINE "conveyor"
OK
%[Process 21:Line 19] - Paused
>>
```

STICK_READ

TYPE:
System Function

SYNTAX:
`value = STICK_READ(flash_file, table_start [,format])`

DESCRIPTION:
Read table data from the SD card to the controller.

Any existing **TABLE** data will be overwritten.

The Binary format gives the best data precision.

PARAMETERS:

value:	**TRUE** = the function was successful **FALSE** = the function was not successful
flash_file:	A number which when appended to the characters "SD" will form the data filename.
table_start:	The start point in the **TABLE** where the data values will be transferred to.
format:	0 = Binary 64bit floating point format, BIN file (default) 1 = **ASCII** comma separated values, CSV file

When storing in format=0 the data is stored in IEEE floating point binary format little-endian, i.e. the least significant byte first.

EXAMPLE:

Read the ASCII CSV file SD001984.csv from the SD card and copy the data to the table memory starting at TABLE(16500)

```
    success = STICK_READ (1984, 16500, 1)
    IF success=TRUE THEN
      PRINT #5,"SD card read OK"
    ENDIF
```

SEE ALSO:

STICK_READVR

STICK_READVR

TYPE:

System Function

SYNTAX:

`value = STICK_READVR(flash_file, vr_start [,format])`

DESCRIPTION:

Read VR data from the SD card to the controller.

Any existing VR data will be overwritten.

The Binary format gives the best data precision.

PARAMETERS:

value:	TRUE = the function was successful FALSE = the function was not successful
flash_file:	A number which when appended to the characters “SD” will form the data filename.
vr_start:	The start point in the VRs where the data values will be transferred to.
format:	0 = Binary 64bit floating point format, BIN file (default) 1 = ASCII comma separated values, CSV file

When storing in format=0 the data is stored in **IEEE** floating point binary format little-endian, i.e. the least significant byte first.

EXAMPLE:

Read the binary file SD002012.bin from the SD card and copy the data to the **VR** memory starting at **VR**(101)

```
    success = STICK_READVR(2012, 101, 0)
    IF success=TRUE THEN
      PRINT #5,"SD card read OK"
    ENDIF
```

SEE ALSO:

STICK_READ

STICK_WRITE

TYPE:

System Function

SYNTAX:

```
value = STICK_WRITE(flash_file, table_start [,length [,format]])
```

DESCRIPTION:

Used to store table data to the SD card in one of two formats.

If this file already exists, it is overwritten.

If you want to store the data without losing any precision use the Binary format.

PARAMETERS:

value:	**TRUE** = the function was successful **FALSE** = the function was not successful
flash_file:	A number which when appended to the characters "SD" will form the data filename.
table_start:	The start point in the **TABLE** where the data values will be transferred from.
length:	The number of the table values to be transferred (default 128 values)

format:	0 = Binary 64bit floating point format, BIN file (default) 1 = **ASCII** comma separated values, CSV file

When storing in format=0 the data is stored in **IEEE** floating point binary format little-endian, i.e. the least significant byte first.

EXAMPLE:
Transfer 2000 values starting at **TABLE**(1000) to the SD Card file ‘called SD1501.BIN

```
    success = STICK_WRITE (1501, 1000, 2000, 0)
```

SEE ALSO:
STICK_WRITEVR

STICK_WRITEVR

TYPE:
System Function

SYNTAX:
```
value = STICK_WRITEVR(flash_file, vr_start [,length [,format]])
```

DESCRIPTION:
Used to store **VR** data to the SD card in one of two formats.

If this file already exists, it is overwritten.

If you want to store the data without losing any precision use the Binary format.

PARAMETERS:

value:	**TRUE** = the function was successful **FALSE** = the function was not successful
flash_file:	A number which when appended to the characters “SD” will form the data filename.
vr_start:	The start point in the **VR**s where the data values will be transferred from.
length:	The number of the **VR** values to be transferred (default 128 values)

format:	0 = Binary 64bit floating point format, BIN file (default) 1 = **ASCII** comma separated values, CSV file

When storing in format=0 the data is stored in **IEEE** floating point binary format little-endian, i.e. the least significant byte first.

EXAMPLE:

Transfer 2000 values starting at **VR**(1000) to the SD Card file 'called SD1501.BIN

```
    success = STICK_WRITEVR (1501, 1000, 2000, 0)
```

SEE ALSO:

STICK_WRITE

STOP

TYPE:

Command

SYNTAX:

```
STOP "progname",[process_number]
```

DESCRIPTION:

Stops one program at its current line. A particular program name may be specified and an optional process number. The process number is required if there is more than one instance of the program running. If no name or process number is included then the selected program will be assumed.

PARAMETERS:

Progname:	name of program to be stopped.
process_number:	optional process number to be used when multiple instances of the program are running and only one is to be stopped.

EXAMPLES:

EXAMPLE 1:

Stop a program called "axis_init" from the command line. Note that quotes are optional unless the program name is also a **BASIC** keyword.

```
    >>STOP axis_init
```

EXAMPLE 2:

Stop the named programs when a digital input goes off.

```
    IF IN(12)=OFF THEN
      STOP "hmi_handler"
      STOP "motion1"
    ENDIF
```

EXAMPLE 3:

Stop one instance of a named program and leave the other instances running.

```
    proc_a = VR(45)  ' process to be stopped is put in the VR by an HMI
    STOP "test_program",proc_a ' stop the required instance of test_program
```

SEE ALSO:

SELECT, RUN

STOP_ANGLE

TYPE:

Axis Parameter

DESCRIPTION:

This parameter is used with **CORNER_MODE**, it defines the maximum change in direction of a 2 axis interpolated move that will be merged at speed. When the change in direction is greater than this angle the reduced to 0.

VALUE:

The angle to reduce the speed to 0, in radians

EXAMPLE:

Reduce the speed to zero on a transition greater than 25 degrees. **DECEL_ANGLE** is set to 25 degrees as well so that there is no reduction of speed below 25 degrees.

```
    CORNER_MODE=2
    STOP_ANGLE=25 * (PI/180)
    DECEL_ANGLE=STOP_ANGLE
```

SEE ALSO:

CORNER_MODE, DECEL_ANGLE

STORE

TYPE:
System Command

DESCRIPTION:
Used by *Motion* Perfect to load Firmware to the controller.

Removing the controller power during a **STORE** sequence can lead to the controller having to be returned to Trio for re-initialization.

STR

TYPE:
STRING Function

SYNTAX:
STR(value[,precision[,width]])

DESCRIPTION:
Converts a numerical value to a string.

PARAMETERS:

value:	Floating-point value to be converted
precision:	Number of decimal places to be used (default=5)
width:	Width of field to be used (default=0, unlimited)

EXAMPLES:

EXAMPLE 1:
Pre-define a variable of type string and use it to store the string conversion of a **VR** variable:

```
    DIM str1 AS STRING(20)
    Str1 = STR(VR(100))
```

SEE ALSO:
CHR, VAL, LEN, LEFT, RIGHT, MID, LCASE, UCASE, INSTR

STRTOD

TYPE:
String Function

SYNTAX:
STRTOD(format, ...)

DESCRIPTION:
The **STRTOD** command reads a sequence of characters and converts them to a numeric value. The conversion stops at the first non-number character found in the input. The characters may be read from the **VR** array or from a TrioBASIC IO channel.

PARAMETERS:
format:

This is a bitwise field that specifies the data source and the number format.

format:	description:	value:
bit 0	Source	0 = **VR** array 1 = TrioBASIC IO channel
bit 1..2	Number format	0 = Floating point 1 = Integer. If the number is not an integer then 0 is returned. 2 = The format is auto-selected to provide the best resolution.

SOURCE = 0:

SYNTAX:
value=**STRTOD**(format, vr_start, vr_index)

DESCRIPTION:
Converts characters in the **VR** array to a number.

PARAMETERS:

Parameter:	Description:
vr_start	Position of the first character of the numeric string in the **VR** array.
vr_index	Position in the **VR** array to store the index of the first non-number character found.

SOURCE = 1:

SYNTAX:
value=**STRTOD**(format, channel, vr_length, vr_index)

DESCRIPTION:
Converts characters from the TrioBASIC channel to a number.

PARAMETERS:

Parameter:	Description:
channel	TrioBASIC IO channel to read. This can be any valid TrioBASIC IO channel: standard communications channel, **ANYBUS** channel, or file channel.
vr_length	Position in the **VR** array to store the length of the number string that was parsed.
vr_index	Position in the **VR** array to store the index of the first non-number character found.

EXAMPLE 1:
```
    >>OPEN #40 AS “n” FOR OUTPUT(1)
    >>PRINT #40,”123.456”
    >>CLOSE #40
    >>OPEN #40 AS “n” FOR INPUT
    >>VR(100)=STRTOD(1,40,101,102)
    >>PRINT VR(100),VR(101),VR(102)
    123.4560     7.0000     13.0000
    >>CLOSE #40
    >>DEL “N”
```

EXAMPLE 2:
```
    >>OPEN #40 AS “n” FOR OUTPUT(1)
    >>PRINT #40,”123.456”
    >>CLOSE #40
    >>OPEN #40 AS “n” FOR INPUT
    >>VR(100)=STRTOD(3,40,101,102)
    >>PRINT VR(100),VR(101),VR(102)
    0.0000     7.0000     13.0000
    >>CLOSE #40
    >>DEL “N”
```

EXAMPLE 3:

```
    >>OPEN #40 AS “n” FOR OUTPUT(1)
    >>PRINT #40,”123”
    >>CLOSE #40
    >>OPEN #40 AS “n” FOR INPUT
    >>VR(100)=STRTOD(3,40,101,102)
    >>PRINT VR(100),VR(101),VR(102)
    123.0000     7.0000     13.0000
    >>CLOSE #40
    >>DEL “N”
```

- Subtract

TYPE:
Mathematical Operator

SYNTAX:
`<expression1> - <expression2>`

DESCRIPTION:
Subtracts expression2 from expression1

PARAMETERS:

Expression1:	Any valid TrioBASIC expression
Expression2:	Any valid TrioBASIC expression

EXAMPLE:
Evaluate 2.1 multiply by 9 and subtract the result from 10, this will then be stored in **`VR`** 0. Therefore **`VR`** 0 holds the value -8.9

```
    VR(0)=10-(2.1*9)
```

SYNC

TYPE:

Axis command

DESCRIPTION:

The **SYNC** command is used to synchronise one axis with a moving position on another axis. It does this by linking the **DPOS** of the slave axis to the **MPOS** of the master. So both axes must be programed in the same scale (for example mm). This can be used to synchronise a robot to a point on a conveyor. The user can define a time to synchronise and de-synchronise.

The synchronising movement on the base axis is the sum of two parts:

- The conveyor movement from the 'sync_pos', this is the movement of the demand point along the conveyor.
- The movement to 'pos1', this is the position in the current **USER_FRAME** where the sync_pos was captured on the slave axis.

When the axis is synchronised it will follow the movements on the 'sync_axis'. As the **SYNC** does not fill the **MTYPE** buffer you can perform movements while synchronised.

To synchronise to a new **USER_FRAME** using **SYNC**(20) requires the kinematic runtime **FEC**

As **SYNC** does not get loaded in to the move buffer it is not cancelled by **CANCEL** or **RAPIDSTOP**, you have to perform **SYNC**(4). When a software or hardware limit is reached the **SYNC** is immediately stopped with no deceleration.

Typically you can use the captured position for example **REG_POS**, or a position from a vision system for the 'sync_position'. The pos1, pos2 and pos3 are typically the position of the sensor/ vision system in the current **USER_FRAME**.

SYNTAX:

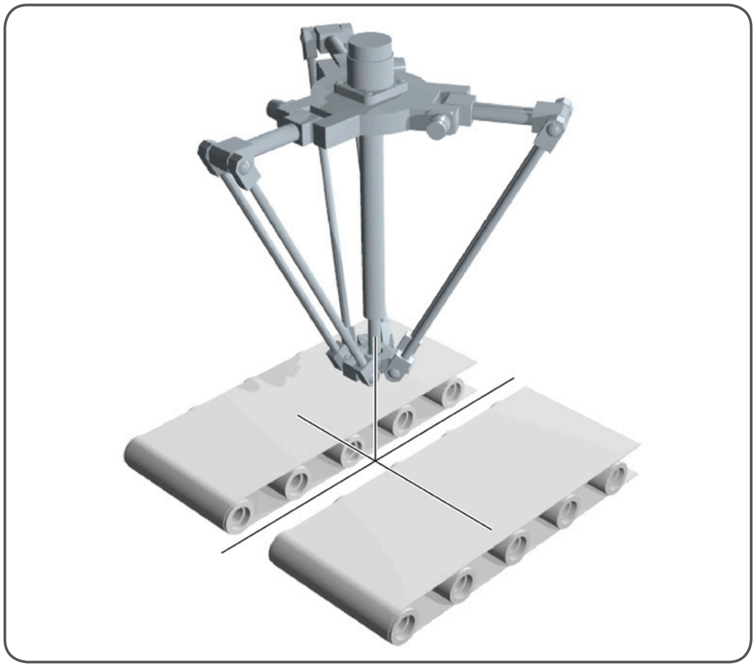
SYNC(control, sync_time, [sync_position, sync_axis, pos1[, pos2 [,pos3]]])

PARAMETERS:

Parameter	Description

control:	1 = Start synchronisation, requires minimum first 5 parameters
	4 = Stop synchronisation, requires minimum first 2 parameters
	10 = Re-synchronise to another axis, requires minimum first 5 parameters
	20 = Re-synchronise to **USER_FRAMEB**, requires minimum first 5 parameters
sync_time:	Time to complete the synchronisation movement in milliseconds
sync_position:	The captured position on the sync_axis.
sync_axis:	The axis to synchronise with.
pos1:	Absolute position on the first axis on the base array
pos2:	Absolute position on the second axis on the base array
pos3:	Absolute position on the third axis on the base array

EXAMPLE:
The robot must pick up the components from one conveyor and place them at 100mm pitch on the second. The registration sensor is at 385mm from the robots origin and the start of the second conveyor is 400mm from the robots origin.



```
'axis(0) - robot axis x
'axis(1) - robot axis y
'axis(2) - robot axis z
'axis(3) - robot wrist rotate
'These are the actual robot axis, FRAME=14 can be applied to these

'axis(10) - conveyor axis
'axis(11) - conveyor axis
'These are the real conveyors that you wish to link to

  'Sensor and conveyor offsets
  sen_xpos = 385
  conv1_yoff = 200
  conv2_yoff = -250
  conv2_xoff = 40
  place_pos = 0

  BASE(0,1)
  'Move to home position.
  MOVEABS(200,50)
  'start conveyors
  DEFPOS(0) AXIS(11) ' reset conveyor position for place
  FORWARD AXIS(10)
  FORWARD AXIS(11)
  WAIT IDLE

  WHILE(running)
    REGIST(20,0,0,0,0) AXIS(10)
    WAIT UNTIL MARK AXIS(10)

    SYNC(1, 1000, REG_POS, 10, sen_xpos , conv1_yoff)
    WAIT UNTIL SYNC_CONTROL AXIS(0)=3
    'Now synchronised
    GOSUB pick

    SYNC(10, 1000, place_pos, 11, conv2_xoff, conv2_yoff)
    WAIT UNTIL SYNC_CONTROL AXIS(0)=3
    'Now synchronised
    GOSUB place

    SYNC(4, 500)
    place_pos = place_pos + 100
  WEND
```

SEE ALSO:
SYNC_CONTROL, SYNC_TIMER, USER_FRAME, USER_FRAMEB

SYNC_CONTROL

TYPE:
Axis parameter (Read Only)

DESCRIPTION:
SYNC_CONTROL returns the current **SYNC** state of the axis

VALUE:

0	No synchronisation
1	Starting synchronisation
2	Performing synchronisation movement
3	Synchronised
4	Stopping synchronisation
5	Starting interpolated movement on second or third axis
6	Performing interpolated movement on second or third axis
10	Starting re- synchronisation
11	Performing re- synchronisation
20	Starting re-synchronisation to a different **USER_FRAME**
21	Performing re-synchronisation to a different **USER_FRAME**

EXAMPLE:
Synchronise to a conveyor linking to a position defined from registration, then wait until synchronisation before picking a part

```
'Set up start position and link to conveyor
  SYNC(10, 500, REG_POS AXIS(5), 5) AXIS(0)
  WAIT UNTIL SYNC_CONTROL AXIS(0)= 3
  GOSUB pick_part
```

SEE ALSO:
SYNC

SYNC_TIMER

TYPE:
Axis parameter (Read Only)

DESCRIPTION:
SYNC_TIMER returns the elapsed time of the synchronisation or re-synchronisation phase of **SYNC**. Once the synchronisation is complete the **SYNC_TIMER** will return the completed synchronisation time.

VALUE:
The elapsed time of the synchronisation phase in milliseconds

EXAMPLE:
Synchronise to a conveyor linking to a position defined from registration, then wait until synchronisation before picking a part

```
‘Set up start position and link to conveyor
  SYNC(10, 500, REG_POS AXIS(5), 5) AXIS(0)
  WAIT UNTIL SYNC_TIMER AXIS(0)= 500
  GOSUB pick_part
```

SEE ALSO:
SYNC

SYSTEM_ERROR

TYPE:
System Parameter

DESCRIPTION:

The system errors are in blocks based on the following byte masks:	
System errors	0x0000ff
Configuration errors	0x00ff00
Unit errors	0xff0000
The following are system errors:	
Ram error	0x000001
Battery error	0x000002

Invalid module error	0x000004
VR/TABLE corrupt entry	0x000008
The following are configuration errors:	
Unit error	0x000100
Station error	0x000200
IO Configuration error	0x000400
Axes Configuration error	0x000800
The following are Unit errors:	
Unit Lost	0x010000
Unit Terminator Lost	0x020000
Unit Station Lost	0x040000
Invalid Unit error	0x080000
Unit Station Error	0x100000

SYSTEM_LOAD

TYPE:
System parameter (Read Only)

DESCRIPTION:
SYSTEM_LOAD returns the amount of time that is used by the system and motion software. The value is expressed as a percentage of the current servo period. The remaining time, that is 100 minus **SYSTEM_LOAD** percent, is therefore available to the application programs.

When setting **SERVO_PERIOD** appropriate to the number of axes running, the value of **SYSTEM_LOAD** should normally not be more than 55%.

VALUE:
The percentage of the servo period time that is used for system and motion processing.

EXAMPLE:
From the terminal 0 command line, read the percentage of servo time being used by the system firmware.

```
>>?SYSTEM_LOAD
23.1390
>>
```

The remaining processing time, 76.8610% is available for the multi-tasking **BASIC** or IEC61131-3 programs.

SEE ALSO:

SYSTEM_LOAD_MAX

SYSTEM_LOAD_MAX

TYPE:

System parameter

DESCRIPTION:

SYSTEM_LOAD_MAX returns the maximum value of **SYSTEM_LOAD** since power-up, or since **SYSTEM_LOAD_MAX** was last set to 0. If **SYSTEM_LOAD_MAX** is greater than 100 then at some point the firmware system and motion processing has overflowed the servo period. The number of axes should be reduced or the **SERVO_PERIOD** set to a higher value.

VALUE:

The maximum percentage of servo period time that is used for system and motion processing.

EXAMPLE 1:

From the terminal 0 command line, read the max percentage of servo time being used by the system firmware.

```
>>?SYSTEM_LOAD_MAX
56.9780
>>
```

EXAMPLE 2:

Reset the **SYSTEM_LOAD_MAX** value so that it can record a new maximum value since reset.

```
>>SYSTEM_LOAD_MAX = 0
>>
```

SEE ALSO:

SYSTEM_LOAD

T_REF

TYPE:
Axis Parameter

DESCRIPTION:
`T_REF` is identical to DAC.

SEE ALSO:
`DAC_OUT`

T_REF_OUT

TYPE:
Axis Parameter

DESCRIPTION:
`T_REF_OUT` is identical to **`DAC_OUT`**.

SEE ALSO:
`DAC_OUT`

TABLE

TYPE:
System Command

SYNTAX:
```
value = TABLE(address [, data0..data35])
```

DESCRIPTION:
The **`TABLE`** command can be used to load and read back the internal **`TABLE`** values. As the table can be written to and read from, it may be used to hold information as an alternative to variables.

The table values are floating point and can therefore be fractional.

You can clear the **`TABLE`** using **`NEW`** “**`TABLE`**”

PARAMETERS:

value:	returns the value stored at the address or -1 if used as part of a write
address:	The address of the first point of a write, or the address to read
data0:	The data written to the address
data1:	The data written to address+1
data2:	The data written to address+2
…	
data35	The data written to address+35

EXAMPLES:

EXAMPLE 1:
This loads the **TABLE** with the following values, starting at address 100:

Table Entry:	Value:
100	0
101	120
102	250
103	370
104	470
105	530

```
    TABLE(100,0,120,250,370,470,530)
```

EXAMPLE 2:
Use the command line to read the value stored in address 1000

```
    >>PRINT TABLE(1000)
    1234.0000
    >>
```

SEE ALSO:
FLASHVR, NEW, TSIZE

TABLE_POINTER

TYPE:
Axis Parameter (Read Only)

DESCRIPTION:
Using the **TABLE_POINTER** command it is possible to determine which **TABLE** memory location is currently being used by the CAM or **CAMBOX**.

TABLE_POINTER returns the current table location that the CAM function is using. The returned number contains the table location and divides up the interpolated distance between the current and next **TABLE** location to indicate exact location.

The user can load new **CAM** data into previously processed **TABLE** location ready for the next **CAM** cycle. This is ideal for allowing a technician to finely tune a complex process, or changing recipes on the fly whilst running.

VALUE:
The value is returned of type X.Y where X is the current **TABLE** location and Y represents the interpolated distance between the start and end location of the current **TABLE** location.

EXAMPLE:
In this example a CAM profile is loaded into **TABLE** location 1000 and is setup on axis 0 and is linked to a master axis 1. A copy of the CAM table is added at location 100. The Analogue input is then read and the CAM **TABLE** value is updated when the table pointer is on the next value.

```
'CAM Pointer demo
'store the live table points
TABLE(1000,0,0.8808,6.5485,19.5501,39.001,60.999,80.4499,93.4515)
TABLE(1008,99.1192,100)
'Store another copy of original points
TABLE(100,0,0.8808,6.5485,19.5501,39.001,60.999,80.4499,93.4515)
TABLE(108,99.1192,100)
'Initialise axes
BASE(0)
WDOG=ON
SERVO=ON

'Set up CAM
CAMBOX(1000,1009,10,100,1, 4, 0)

'Start Master axis
BASE(1)
SERVO=ON
SPEED=10
```

```
FORWARD

'Read Analog input and scale CAM based on input
pointer=0
WHILE 1
'Read Analog Input (Answer 0-10)
scale=AIN(32)*0.01
'Detects change in table pointer
IF INT(TABLE_POINTER)<>pointer THEN
    pointer=INT(TABLE_POINTER)
    'First value so update last value
    IF pointer=1000 THEN
        TABLE(1008,(TABLE(108)*scale))
    'Second Value, so must update First & Last but 1 value
    ELSEIF pointer=1001 THEN
        TABLE(1000,(TABLE(100)*scale))
        TABLE(1009,(TABLE(109)*scale))
    'Update previous value
    ELSE
        TABLE(pointer-1, (TABLE(pointer-901)*scale))
    ENDIF
ENDIF
WEND
STOP
```

SEE ALSO:
CAM, **CAMBOX**, **TABLE**

TABLEVALUES

TYPE:
System Command

SYNTAX:
TABLEVALUES(first, last [,format])

DESCRIPTION:
Returns a list of table values starting at the table address specified. The output is a comma delimited list of values.

TABLEVALUES is provided for *Motion* Perfect to allow for fast access to banks of **TABLE** values.

PARAMETERS:

first:	First **TABLE** address to be returned
last:	Last **TABLE** address to be returned
format:	Format for the list.
	0 = Uncompressed comma delimited text (default) 1 = Compressed comma delimited text, repeated values are compressed using a repeat count before the value (k7,0.0000 representing 7 successive values of 0.0000). Single values do not have the repeat count;

EXAMPLE:

For a controller containing the values 0.0, 0.1, 0.1, 0.1, 0.2, 0.2, 0.0 in addresses 1 to 7:-

```
>>TABLEVALUES(1,7,0)
0.0000,0.1000,0.1000,0.1000,0.2000,0.2000,0.0000
>>
>>TABLEVALUES(1,7,1)
0.0000,k3,0.1000,k2 0.2000,0.0000
>>
```

TAN

TYPE:

Mathematical Function

SYNTAX:

`value = TAN(expression)`

DESCRIPTION:

Returns the **TANGENT** of an expression. This is valid for any value expressed in radians.

PARAMETERS:

value:	The **TANGENT** of the expression
expression:	Any valid TrioBASIC expression.

EXAMPLE:

Print the tangent of 0.5 using the command line.

```
>>PRINT TAN(0.5)
 0.5463
>>
```

TANG_DIRECTION

TYPE:
Axis Parameter

DESCRIPTION:
When used with a 2 axis X-Y system, this parameter returns the angle in radians that represents the vector direction of the interpolated axes.

VALUE:
The value returned is between -PI and +PI and is determined by the directions of the interpolated axes.

value	X	Y
0	0	1
PI/2	1	0
PI/2 (+PI or -PI)	0	-1
-PI/2	-1	0

EXAMPLES:

EXAMPLE1:
Note scale_factor_x **MUST** be the same as scale_factor_y

```
UNITS AXIS(4)=scale_factor_x
UNITS AXIS(5)=scale_factor_y
BASE(4,5)
MOVE(100,50)
angle = TANG_DIRECTION
```

EXAMPLE2:

```
BASE(0,1)
angle_deg = 180 * TANG_DIRECTION / PI
```

TEXT_FILE_LOADER

TYPE:
Command

SYNTAX:

TEXT_FILE_LOADER[(function [, parameter[,value]])]

DESCRIPTION:

The **TEXT_FILE_LOADER** command controls the **TEXT_FILE_LOADER_PROGRAM** on the controller. This function allows the **TEXT_FILE_LOADER** to be controlled and configured from the **BASIC**. **TEXT_FILE_LOADER_PROC** can be set to define which process the **TECT_FILE_LOADER_PROGRAM** runs on.

The **TEXT_FILE_LOADER_PROGRAM** is the controller end of the fast file transfer process that communicates with the file loading functionality of PCMotion.

If no parameters are used then the function is 0.

PARAMETERS:

function:	description:
0	Run the **TEXT_FILE_LOADER** program
1	Read a **TEXT_FILE_LOADER** parameter
2	Write a **TEXT_FILE_LOADER** parameter

FUNCTION = 0:

SYNTAX:

TEXT_FILE_LOADER

TEXT_FILE_LOADER (0)

DESCRIPTION:

Starts up the **TEXT_FILE_LOADER** communication protocol as a program. The **TEXT_FILE_LOADER** program will take up a user process if it is run automatically or manually.

The **TEXT_FILE_LOADER** program is normally started automatically when you open a file load connection. You can call it manually if you wish to specify which process it should run on.

If you execute **TEXT_FILE_LOADER** manually the program it runs in will suspend at the **TEXT_FILE_LOADER** line. The **TEXT_FILE_LOADER** therefore should be the last line of the program to execute.

FUNCTION = 1 AND FUNCTION = 2:

SYNTAX:

value = **TEXT_FILE_LOADER** (function, parameter [,value])

DESCRIPTION:

Functions 1 and 2 are used to (1) read and (2) write parameters from the **TEXT_FILE_LOADER_PROGRAM**.

The default destination for transparent protocol transfers should be set before any transfers occur.

PARAMETERS:

Parameter:	Description:	Values:
0	Transfer status parameter (read only)	0 = no transfer active 1 = transfer active
1	Default destination for transparent transfers	0 = **TEMP** file 1 = **FIFO** file 2 = **SDCARD**

EXAMPLES:

EXAMPLE 1:

Wait for a transfer to start then process the characters as they arrive at on the controller.

```
` wait for a file transfer to start
WAIT UNTIL TEXT_FILE_LOADER(1,0) = 1

` process this file
WHILE KEY#fifo_channel
    GET#fifo_channel,k
    PRINT #echo_channel,CHR(k);
    IF k=13 THEN PRINT #echo_channel, CHR(10);

    IF k>=65 AND k<=90 THEN 'A to Z
        ltflag=0
        spflag=0
        value=0
        GOTO command_pro
    ENDIF
WEND
```

EXAMPLE 2:

Load a file into a **FIFO** then configure the **FILE** to be read back into the **BASIC**.

```
'Set the FIFO as default file location for transparent protocol
TEXT_FILE_LOADER(2,1,1)
` initialise fifo
OPEN #fifo_channel AS "TRANSFER_FILE" FOR FIFO_WRITE(fifo_size)
CLOSE #fifo_channel
```

```
    ` open fifo to read
    OPEN #fifo_channel AS "TRANSFER_FILE" FOR FIFO_READ

    ` run
    WHILE running
        ` wait for a file transfer to start
        WAIT UNTIL TEXT_FILE_LOADER(1,0)
        WHILE KEY#fifo_channel
            GET#fifo_channel,char
            PRINT#5, CHR(char)
        WEND
    WEND
```

SEE ALSO:

TEXT_FILE_LOADER_PROC

TEXT_FILE_LOADER_PROC

TYPE:

System Parameter (**MC_CONFIG**)

DESCRIPTION:

When the TrioPC ActiveX starts a text file transfer to the *Motion Coordinator*, the **TEXT_FILE_LOADER_ PROGRAM** is started on the highest available process. **TEXT_FILE_LOADER _PROC** can be set to specify a different process for the **TEXT_FILE_LOADER _PROGRAM**. If the defined process is in use then the next lower available process will be used.

TEXT_FILE_LOADER _PROC can be set in the MC_**CONFIG** script file.

VALUE:

-1	Use the highest available process (default)
0 to max process	Run on defined process

EXAMPLES:

EXAMPLE1:

Set **TEXT_FILE_LOADER _PROGRAM** to start on process 19 or lower (using the command line terminal).

```
    >> TEXT_FILE_LOADER_PROC=19
    >>
```

EXAMPLE2:

Remove the **TEXT_FILE_LOADER _PROC** setting so that **TEXT_FILE_LOADER _PROGRAM** starts on default process (using **MC_CONFIG**).

```
 'MC_CONFIG script file
TEXT_FILE_LOADER_PROC = -1  'Start on default process on connection
```

SEE ALSO:

TEXT_FILE_LOADER

TICKS

TYPE:

Process Parameter

DESCRIPTION:

The current count of the process clock ticks is stored in this parameter. The process parameter is a 64 bit counter which is **DECREMENTED** on each servo cycle. It can therefore be used to measure cycle times, add time delays, etc. The ticks parameter can be written to and read.

As **TICKS** is a process parameter each process will have its own counter.

VALUE:

The value of the 64bit counter

EXAMPLE:

With **SERVO_PERIOD** set to 1000 use **TICKS** for a 3 second delay

```
delay:
 TICKS=3000
 OP(9,ON)
test:
 IF TICKS<=0 THEN OP(9,OFF) ELSE GOTO test
```

TIME$

TYPE:

System Parameter

DESCRIPTION:

TIME$ is used as part of a **PRINT** statement or a **STRING** variable to write the current time from the real time clock. The date is printed in the format Hour:Minute:Second.

The **TIME$** is set through the **TIME** command

PARAMETERS:

None.

EXAMPLES

EXAMPLE 1:

Print the current time from the real time clock to the command line.

```
>>print time$
15:51:06
>>
```

EXAMPLE 2:

Create an error message to print later in the program

```
DIM string1 AS STRING(30)
string1 = "Error occurred at " + TIME$
```

SEE ALSO:

PRINT, STRING, TIME

TIME

TYPE:

System Parameter

DESCRIPTION:

Allows the user to set and read the time from the real time clock.

VALUE:

Read = the number of seconds since midnight (24:00 hours)

Write = the time in 24hour format hh:mm:ss

EXAMPLES:

EXAMPLE 1:
Sets the real time clock in 24 hour format; hh:mm:ss

```
    'Set the real time clock
    >>TIME = 13:20:00
```

EXAMPLE 2:
Calculate elapsed time in seconds

```
    time1 = TIME
    'wait for event
    time2 = TIME
    timeelapsed = time1-time2
```

SEE ALSO:
TIME$

TIMER

TYPE:
Command

SYNTAX:
TIMER(switch, output, pattern, time[,option])

DESCRIPTION:
The **TIMER** command allows an output or a selection of outputs to be set or cleared for a predefined period of time. There are 64 timer slots available, each can be assigned to any outputs. The timer can be configured to turn the output ON or OFF.

PARAMETERS:

switch:	The timer number in the range 0-63
output:	Selects the physical output or first output in a group. Range 0-31.
pattern:	1 = for a single output. Number = If set to a number this represents a binary array of outputs to be turned on. Range 0-65535.

time:	The period of operation in milliseconds
option:	Inverts the output, set to 1 to turn OFF at start and ON at end.

EXAMPLES:

EXAMPLE1:

Use the **`TIMER`** function to flash an output when there is a motion error. The output lamp should flash with a 50% duty cycle at 5Hz.

```
WAIT UNTIL MOTION_ERROR
 WHILE MOTION_ERROR
 TIMER(0,8,1,100) 'turns ON output 8 for 100milliseconds
 WA(200) 'Waits 200 milliseconds to complete the 5Hz period
WEND
```

EXAMPLE2:

Setting outputs 10, 12 and 13 OFF for 70 milliseconds following a registration event. The first output is set to 10 and the pattern is set to 13 (1 0 1 1 in binary) to enable the three outputs. Output 11 is still available for normal use. The option value is set to 1 to turn OFF the outputs for the period, they return to an ON state after the 70 milliseconds has elapsed.

```
WHILE running
 REGIST(3)
 WAIT UNTIL MARK
 TIMER(1,10,13,70,1)
WEND
```

EXAMPLE3:

Firing output 10 for 250 milliseconds during the tracking phase of a **`MOVELINK`** Profile

```
WHILE feed=ON
 MOVELINK(30,60,60,0,1)
 MOVELINK(70,100,0,60,1)
 WAIT LOADED 'Wait until the tracking phase starts
 TIMER(42,10,1,250) 'Fire the output during the tracking phase
 MOVELINK(-100,200,50,50,1)
WEND
```

TIMER

TYPE:

Command

SYNTAX:

TIMER(switch, output, pattern, time[,option])

DESCRIPTION:

The **TIMER** command allows an output or a selection of outputs to be set or cleared for a predefined period of time. There are 64 timer slots available, each can be assigned to any outputs. The timer can be configured to turn the output ON or OFF.

PARAMETERS:

switch:	The timer number in the range 0-63
output:	Selects the physical output or first output in a group. Range 0-31.
pattern:	1 = for a single output. Number = If set to a number this represents a binary array of outputs to be turned on. Range 0-65535.
time:	The period of operation in milliseconds
option:	Inverts the output, set to 1 to turn OFF at start and ON at end.

EXAMPLES:

EXAMPLE1:

Use the **TIMER** function to flash an output when there is a motion error. The output lamp should flash with a 50% duty cycle at 5Hz.

```
WAIT UNTIL MOTION_ERROR
 WHILE MOTION_ERROR
 TIMER(0,8,1,100) 'turns ON output 8 for 100milliseconds
 WA(200) 'Waits 200 milliseconds to complete the 5Hz period
WEND
```

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Setting outputs 10, 12 and 13 OFF for 70 milliseconds following a registration event. The first output is set to 10 and the pattern is set to 13 (1 0 1 1 in binary) to enable the three outputs. Output 11 is still available for normal use. The option value is set to 1 to turn OFF the outputs for the period, they return to an ON state after the 70 milliseconds has elapsed.

```
WHILE running
 REGIST(3)
 WAIT UNTIL MARK
 TIMER(1,10,13,70,1)
WEND
```

EXAMPLE3:

Firing output 10 for 250 milliseconds during the tracking phase of a **MOVELINK** Profile

```
WHILE feed=ON
```

```
     MOVELINK(30,60,60,0,1)
     MOVELINK(70,100,0,60,1)
     WAIT LOADED 'Wait until the tracking phase starts
     TIMER(42,10,1,250) 'Fire the output during the tracking phase
     MOVELINK(-100,200,50,50,1)
    WEND
```

TOOL_OFFSET

TYPE:

Axis Command

SYNTAX

TOOL_OFFSET(identity, x_offset, y_offset, z_offset)

DESCRIPTION:

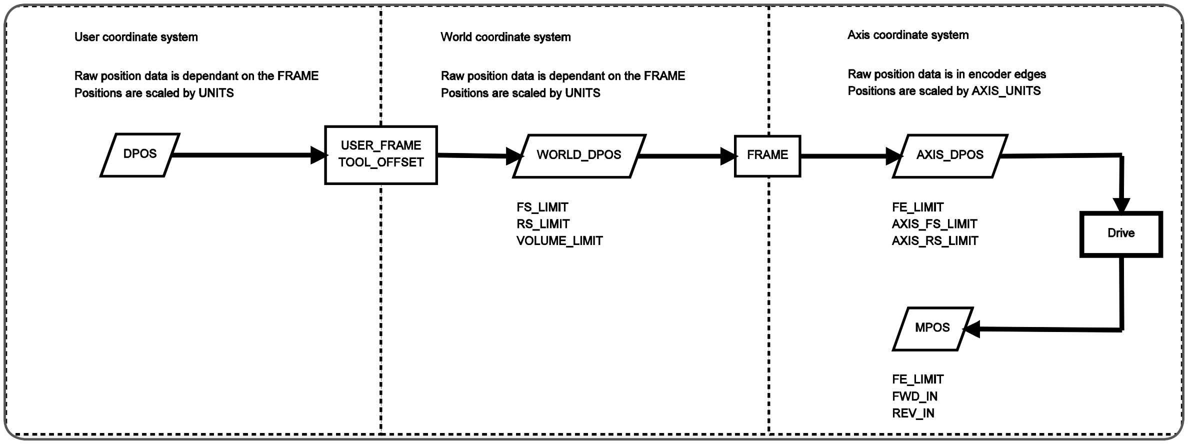
TOOL_OFFSET is used to adjust the programming point on a system. This is achieved by offsetting **DPOS** from the programming point. For example a wrist of the robot is the programming point and the tool offset can be used to adjust the programming point to the end of a tool on the wrist. Multiple tool points can be assigned and the user can switch between points on the fly.

TOOL_OFFSET requires the kinematic runtime **FEC**

The default **TOOL_OFFSET** has the identity 0 and is equal to the world coordinate system origin, this cannot be modified. If you wish to disable the **TOOL_OFFSET** select **TOOL_OFFSET**(0).

TOOL_OFFSETs are applied on the axis **FRAME_GROUP**. If no **FRAME_GROUP** is defined then a runtime error will be generated. **TOOL_OFFSET** supports a **FRAME_GROUP** containing 2-6 axes.

Movements are loaded with the selected **TOOL_OFFSET**. This means that you can buffer a sequence of movements on different tools. The active **TOOL_OFFSET** is the one associated with the movement in the **MTYPE**. If the **FRAME_GROUP** is **IDLE** then the active **TOOL_OFFSET** is the selected **TOOL_OFFSET**.


User coordinate system
Raw position data is dependant on the FRAME
Positions are scaled by UNITS
World coordinate system
Raw position data is dependant on the FRAME
Positions are scaled by UNITS
Axis coordinate system
Raw position data is in encoder edges
Positions are scaled by AXIS_UNITS
DPOS
USER_FRAME
TOOL_OFFSET
WORLD_DPOS
FRAME
AXIS_DPOS
Drive
MPOS
FS_LIMIT
RS_LIMIT
VOLUME_LIMIT
FE_LIMIT
AXIS_FS_LIMIT
AXIS_RS_LIMIT
FE_LIMIT
FWD_IN
REV_IN

If you wish to check which **USER_FRAME**, **TOOL_OFFSET** and **VOLUME_LIMIT** are active you can print the details using **FRAME_GROUP**(group).

PARAMETERS

identity:	0 = default group which is set to the world coordinate system
	1 to 31 = Identification number for the user defined tool offset.
x_offset:	Offset in the x axis from the world origin to the user origin.
y_offset:	Offset in the y axis from the world origin to the user origin.
z_offset:	Offset in the z axis from the world origin to the user origin.

EXAMPLE

A tool is rotated 45degrees about the y axis and has an offset of 20mm in the x direction, 30mm in the y direction and 300mm in the z direction. The programmer wants to move the tool forward on its axis so a **TOOL_OFFSET** is applied to adjust the position to the tool tip, then a USER_FRAMEis applied to allow programming about the tool axis.

```
'Configure USER_FRAME and TOOL_OFFSET
FRAME_GROUP(0,0,0,1,2)
USER_FRAME(1, 20, 30, 300, 0, PI/4, 0)
TOOL_OFFSET(1, 20, 30, 300)
'Select tool and frame and start motion.
USER_FRAME(1)
TOOL_OFFSET(1)
BASE(2)
FORWARD
```

TRIGGER

TYPE:
System Command

DESCRIPTION:
Starts a previously set up **SCOPE** command. This allows you to start the scope capture at a specific part of your program.

EXAMPLE:
The *Motion* Perfect oscilloscope is set to record **MPOS** and **DPOS** of axis 0. The settings allow for program trigger and a repeat trigger. This loop can then be used as part of a PID tuning routine.

```
WHILE IN(tuning)=ON
DEFPOS(0)
TRIGGER
 WA(5) 'Allow the scope to start
 MOVE(100)
 WAIT IDLE
 WA(100)
 MOVE(-100)
 WA(100)
WEND
```

TRIOPCTESTVARIAB

TYPE:
Reserved Keyword

TROFF

TYPE:
System Command

SYNTAX:
TROFF ["program"]

DESCRIPTION:
The trace off command resumes execution of the **SELECTed** or specified program. The command can be

included in a program to resume the execution of that program.

For de-bugging the *Motion* Perfect breakpoint tool should be used.

PARAMETERS:

program:	The name of the program which you wish to resume

EXAMPLE:

Resume execution of a program names **TEST**

```
    >>TROFF "TEST"
    OK
    >>%[Process 21:Program TEST] - Released
```

SEE ALSO:

HALT, STOP, STEPLINE, TRON

TRON

TYPE:

System Command

SYNTAX:

`TRON ["program"]`

DESCRIPTION:

The trace on command pauses the **SELECTed** or specified program. The command can be included in a program to pause the execution of that program. The program can then be stepped through a single line, run or halted.

PARAMETERS:

program:	The name of the program which you wish to step

Motion Perfect highlights lines containing **TRON** in its editor and debugger. For de-bugging the *Motion* Perfect breakpoint tool should be used.

EXAMPLES:

EXAMPLE 1:

Use suspend a program by including **TRON**. Another program will then use **STEPLINE** to step through until the **TRON**.

```
    TRON
    MOVE(0,10)
    MOVE(10,0)
    TROFF
    MOVE(0,-10)
    MOVE(-10,0)
```

EXAMPLE 2:

Start a program by stepping into the first line, then stepping through. The line that is stepped to is displayed

```
    >>SELECT "STARTUP"
    STARTUP selected
    >>TRON
    OK
    >>%[Process 20:Line 3] - Paused
    TABLE(0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0)

    STEPLINE
    OK
    >>%[Process 20:Line 4] - Paused
    TABLE(10,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0)

    STEPLINE
    OK
    >>%[Process 20:Line 5] - Paused
    TABLE(20,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0)
```

EXAMPLE 3:

Pause a program called test that is currently running:

```
    TRON "TEST"
    OK
    >>%[Process 21:Line 6] - Paused
    WA(4)
```

SEE ALSO:

HALT, **STOP**, **STEPLINE**, **TROFF**

TRUE

TYPE:

Constant

DESCRIPTION:

The constant **TRUE** takes the numerical value of -1.

EXAMPLE:
Checks that the logical result of input 0 and 2 is true

```
t=IN(0)=ON AND IN(2)=ON
IF t=TRUE THEN
 PRINT "Inputs are on"
ENDIF
```

TSIZE

TYPE:
System Parameter (Read Only)

DESCRIPTION:
Returns the size of the **TABLE**.

Not all table positions are battery backed, see your controller information for exact values.

VALUE:
The size of the **TABLE**

EXAMPLE:
Check the size of the table and write to the last position in the table (remember the table starts at position 0).

```
>>?tsize
500000.0000
>>table(499999,123)
>>
```

UCASE

TYPE:
STRING Function

SYNTAX:
```
UCASE(string)
```

DESCRIPTION:
Returns a new string with the input string converted to all upper case.

PARAMETERS:

string:	String to be used

EXAMPLES:

EXAMPLE 1:
Pre-define a variable of type string and later print it in all upper case characters:
```
    DIM str1 AS STRING(32)
    str1 = "Trio Motion Technology"
    PRINT UCASE(str1)
```

SEE ALSO:
CHR, STR, VAL, LEFT, RIGHT, MID, LEN, LCASE, INSTR

UNIT_CLEAR

TYPE:
System command

DESCRIPTION:
Clears all the bits in the **UNIT_ERROR** system parameter.

VALUE:
This command takes no values

EXAMPLE:
Clear the **UNIT_ERROR** bits and then check for which module or modules may be in error.
```
    UNIT_CLEAR
    WA(10)
    PRINT UNIT_ERROR[0]
```

SEE ALSO:
`SLOT, SYSTEM_ERROR, UNIT_ERROR`

UNIT_DISPLAY

TYPE:
System Parameter

DESCRIPTION:
Reserved Keyword

UNIT_ERROR

TYPE:
System Parameter (read only)

DESCRIPTION:
The **`UNIT_ERROR`** provides a simple single indicator that at least one module is in error and can indicate multiple modules that have an error. The value returns details which SLOTs are in error.

VALUE:
A binary sum of the module **`SLOT`** numbers for the modules which are in error.

Bit	Value	Slot
0	1	0
1	2	1
2	4	2
3	8	3
…		

EXAMPLE:
Test for the module in slot 1 having an error which is a ‘Unit station error’. This could indicate a problem with a drive on the network in slot 1.

```
    IF UNIT_ERROR=2 AND SYSTEM_ERROR=1048576 THEN
      ‘Handle Unit station error for slot 1
    ...
  ENDIF
```

SEE ALSO:

SLOT, SYSTEM_ERROR, UNIT_CLEAR

UNIT_SW_VERSION

TYPE:

Reserved Keyword

UNITS

TYPE:

Axis Parameter

DESCRIPTION:

UNITS is a conversion factor that allows the user to scale the edges/ stepper pulses to a more convenient scale. The motion commands to set speeds, acceleration and moves use the **UNITS** scalar to allow values to be entered in more convenient units e.g.: mm for a move or mm/sec for a speed.

Units may be any positive value but it is recommended to design systems with an integer number of encoder pulses/user unit. If you need to use a non integer number you should use **ENCODER_RATIO**. **STEP_RATIO** can be used for non integer conversion on a stepper axis.

VALUE:

The number of counts per required units.

EXAMPLES:

EXAMPLE 1:

A leadscrew arrangement has a 5mm pitch and a 1000 pulse/rev encoder. The units should be set to allow moves to be specified in mm.

The 1000 pulses/rev will generate 1000 x 4=4000 edges/rev in the controller. One rev is equal to 5mm therefore there are 4000/5=800 edges/mm.

```
>>UNITS=1000*4/5
```

EXAMPLE 2:

A stepper motor has 180 pulses/rev. There is a built in 16 multiplier so the controller will use 180*16 counts per revolution.

To program in revolutions the unit conversion factor will be:

```
    >>UNITS=180*16
```

SEE ALSO:

ENCODER_RATIO, STEP_RATIO

UNLOCK

TYPE:

System Command (command line only)

SYNTAX:

UNLOCK(code)

DESCRIPTION:

Unlocks a *Motion Coordinator* which has previously been locked using the **LOCK** command.

To unlock the *Motion Coordinator*, the **UNLOCK** command should be entered using the same security code number which was used originally to **LOCK** it.

You should use *Motion* Perfect to **LOCK** and **UNLOCK** your controller.

If you forget the security code number which was used to lock the *Motion Coordinator*, it may have to be returned to your supplier to be unlocked.

PARAMETERS:

code:	Any 7 digit integer number

SEE ALSO:

LOCK

USER_FRAME

TYPE:

Axis Command

SYNTAX

USER_FRAME(identity [, x_offset, y_offset, z_offset [, x_rotation [, y_rotation [, z_rotation]]]])

DESCRIPTION:

The **USER_FRAME** allows the user to program in a different coordinate system. The **USER_FRAME** can be defined up to a 3-axis translation and rotation from the world coordinate origin. The rotations are applied using the Euler ZYX convention. This means that the z rotation is applied first, then the y is applied on the new coordinate system and finally the x is applied. The coordinate system is defined using the 'right hand rule' and the rotation of the origin is defined using the 'right hand turn'.

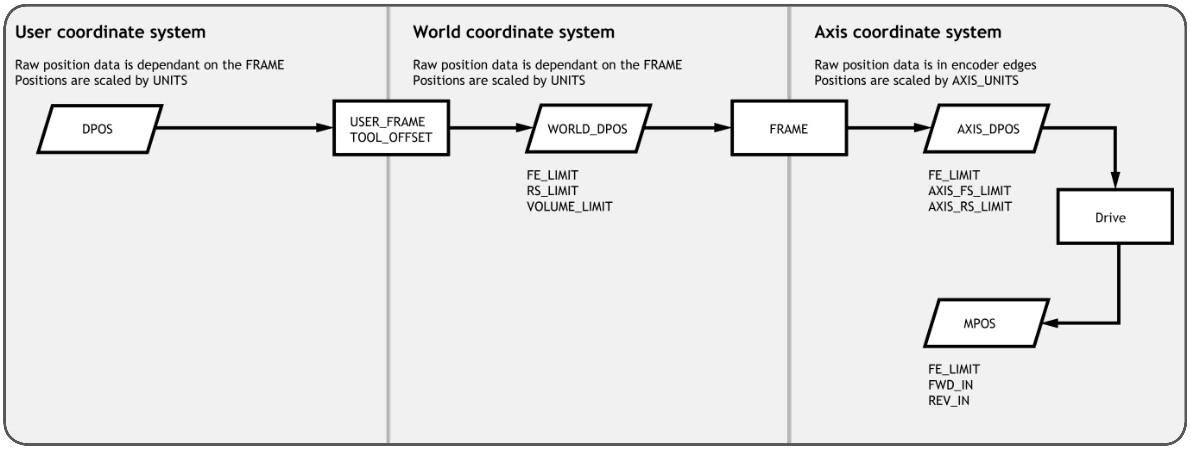
USER_FRAME requires the kinematic runtime **FEC**

The default coordinate system has the identity 0 and is equal to the world coordinate system, this cannot be modified. If you wish to disable the **USER_FRAME** select **USER_FRAME**(0).

USER_FRAMEs are applied on the axis **FRAME_GROUP**. If no **FRAME_GROUP** is defined then a runtime error will be generated.

Movements are loaded with the selected **USER_FRAME**. This means that you can buffer a sequence of movements on different **USER_FRAMES**. The active **USER_FRAME** is the one associated with the movement in the **MTYPE**. If the **FRAME_GROUP** is **IDLE** then the active **USER_FRAME** is the selected **USER_FRAME**.

The **USER_FRAME** is applied to all the axes in the **FRAME_GROUP**. This can be the same group as used by **FRAME**. The **FRAME_GROUP** does not have to be 3 axis, however the **USER_FRAME** will only process position for the axes in the **FRAME_GROUP**. It can be useful in a 2 axes **FRAME_GROUP** to perform a **USER_FRAME** rotation about the third axis.


User coordinate system
Raw position data is dependant on the FRAME
Positions are scaled by UNITS
DPOS
USER_FRAME
TOOL_OFFSET
World coordinate system
Raw position data is dependant on the FRAME
Positions are scaled by UNITS
WORLD_DPOS
FE_LIMIT
RS_LIMIT
VOLUME_LIMIT
FRAME
Axis coordinate system
Raw position data is in encoder edges
Positions are scaled by AXIS_UNITS
AXIS_DPOS
FE_LIMIT
AXIS_FS_LIMIT
AXIS_RS_LIMIT
Drive
MPOS
FE_LIMIT
FWD_IN
REV_IN

If you wish to check which **USER_FRAME**, **TOOL_OFFSET** and **VOLUME_LIMIT** are active you can print the details using **FRAME_GROUP**(group).

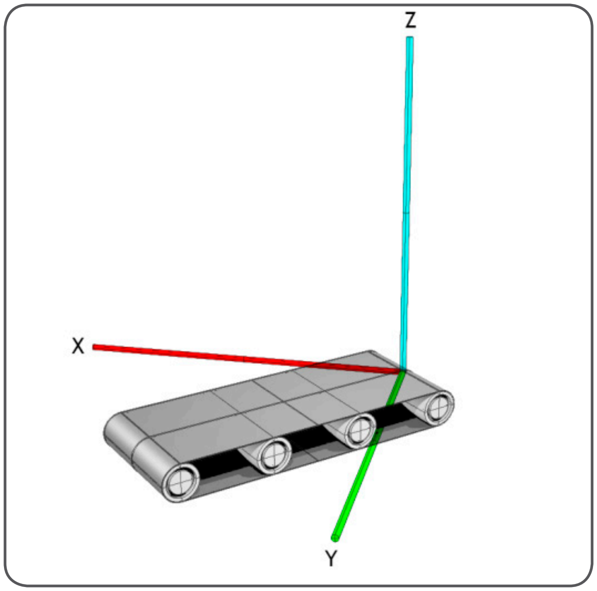
PARAMETERS

identity:	0 = default group which is set to the world coordinate system
	1 to 31 = Identification number for the user defined frame.
x_offset:	Offset in the x axis from the world origin to the user origin.
y_offset:	Offset in the y axis from the world origin to the user origin.
z_offset:	Offset in the z axis from the world origin to the user origin.
x_rot:	Rotation about the items x axis in radians.
y_rot:	Rotation about the items y axis in radians.
z_rot:	Rotation about the items z axis in radians.

EXAMPLES:

EXAMPLE 1:

A conveyors origin is at 45degrees to the world coordinate (robots) origin, as shown in the image. To ease programming a **USER_FRAME** is assigned to align the x axis with the conveyor so that it is possible to program in the conveyor coordinate system.



```
FRAME_GROUP(0,0,0,1,2)
USER_FRAME(1,0,0,0,PI/4)
```

EXAMPLE 2

Initialise a user coordinate system then perform a movement on the world coordinate system before starting a **FORWARD** on the first user coordinate system.

```
    FRAME_GROUP(0,0,0,1,2)
    BASE(0,1,2)
    DEFPOS(10,20,30)
    USER_FRAME(1,10,20,30,PI/2)
    USER_FRAME(0)
    MOVEABS(100,100,50)
    WAIT IDLE
    USER_FRAME(1)
    FORWARD
```

USER_FRAME_TRANS

TYPE:

Mathematical Function

SYNTAX:

`USER_FRAME_TRANS(user_frame_in, user_frame_out, tool_offset_in, tool_offset_out, table_in,  table_out, [scale])`

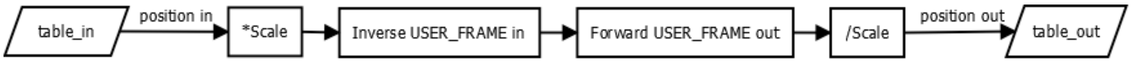
DESCRIPTION:

This function enables you to transform a set of positions from one frame to another. This could be used to take a set of positions from a vision system and transform them so that they are a set of positions relative to a conveyor.

USER_FRAME_TRANS requires the kinematic runtime **FEC**

It is required to set-up a **FRAME_GROUP** and **USER_FRAME** to use this function. If you do not wish to set up a **FRAME_GROUP** with real axis you can use virtual.

The **USER_FRAME** calculations are performed on raw position data which are integers. The table data is scaled by the scale parameter, for optimal resolution scale should be set to the **UNITS** of the robot.



As all the **USER_FRAME** transformations use the same coordinate scale it does not matter if the positions are supplied as raw positions or scaled by **UNITS**.

PARAMETERS:

user_frame_in:	The **USER_FRAME** identity that the points are supplied in
user_frame_out:	The **USER_FRAME** identity that the points are transformed to
tool_offset_in:	The **TOOL_OFFSET** identity that the points are supplied in
tool_offset_out:	The **TOOL_OFFSET** identity that the points are transformed to
table_in:	The start of the input positions
table_out:	The start of the generated positions
scale:	This parameter allows you to scale the table values (default 1000)

The table_in requires 12 values. Any that are not required should be set to zero for position and 1 for scale.

table_in	First axis position
table_in +1	Second axis position
table_in +2	Third axis position
table_in +3	Fourth axis position
table_in +4	Fifth axis position
table_in +5	Sixth axis position
table_in +6	First axis **FRAME_SCALE**
table_in +7	Second axis **FRAME_SCALE**
table_in +8	Third axis **FRAME_SCALE**
table_in +9	Fourth axis **FRAME_SCALE**
table_in +10	Fifth axis **FRAME_SCALE**
table_in +11	Sixth axis **FRAME_SCALE**

EXAMPLE:

USER_FRAME(vision) has been configured to the vision system relative to the robot origin. The conveyor has been configures in **USER_FRAME**(conveyor). To use the vision system positions on the conveyor **USER_FRAME** they must be transformed through **USER_FRAME_TRANS**.

```
    USER_FRAME_TRANS(vision, conveyor, 0, 0, 200,300)
```

USER_FRAMEB

TYPE:
Axis Command

SYNTAX
USER_FRAMEB(identity)

DESCRIPTION:
USER_FRAMEB is only used with **SYNC**. It defines the new **USER_FRAME** to resynchronise to when performing the **SYNC**(20) operation. When the resynchronisation is complete **USER_FRAMEB** is the active **USER_FRAME**. **USER_FRAMEB** selects one of the defined USER_FRAMEs.

EXAMPLE:
The robot must pick up the components from one conveyor and place them on a second conveyor which is in a different **USER_FRAME**.

```
WHILE(running)
  USER_FRAMEB(conv1)
  REGIST(20,0,0,0,0) AXIS(10)
  WAIT UNTIL MARK AXIS(10)

  SYNC(1, 1000, REG_POS, 10, sen_xpos , conv1_yoff)
  WAIT UNTIL SYNC_CONTROL AXIS(0)=3
  'Now synchronised
  GOSUB pick

  USER_FRAMEB(conv2)
  SYNC(20, 1000, place_pos, 11, conv2_xoff, conv2_yoff)
  WAIT UNTIL SYNC_CONTROL AXIS(0)=3
  'Now synchronised
  GOSUB place

  SYNC(4, 500)
  place_pos = place_pos + 100
WEND
```

SEE ALSO:
SYNC, USER_FRAME

VAL

TYPE:
STRING Function

SYNTAX:
`VAL(string)`

DESCRIPTION:
Converts a string to a numerical value. If the string is not a numerical value then VAL returns 0.

PARAMETERS:

string:	String to be converted

EXAMPLES:

EXAMPLE 1:
Pre-define a variable of type string and then later, convert its current value to a numerical value stored in a VR. The resulting number in the VR is -132.456:

```
    DIM str1 AS STRING(20)
    str1 = "-123.456"
    VR(100)=VAL(str1)
```

EXAMPLE 2:
Pre-define a variable of type string and then later, convert its current value to an integer numerical value stored in a local variable. The resulting number in the local variable is 1110:

```
    DIM str2 AS STRING(10)
    DIM number AS INTEGER
    str2 = "987"
    number = INT(VAL(str2)) + 123
```

SEE ALSO:
CHR, STR, LEN, LEFT, RIGHT, MID, LCASE, UCASE, INSTR

VALIDATE_ENCRYPTION_KEY

TYPE:
System Command

SYNTAX:

`VALIDATE_KEY (security_code_type, validation_key)`

DESCRIPTION:

`VALIDATE_ENCRYPTION_KEY` is used to check that the controller has the correct user or OEM security code programmed. If the correct security code is not programmed then **`VALIDATE_ENCRYPTION_KEY`** will produce a runtime error (parameter out of range) and so stop the program from functioning.

Motion Perfect has a tool to generate the validation keys

Do not put the user or **`OEM`** security code in the program as these must be kept secret.

PARAMETERS:

security_code_type	1	OEM security code
	2	User security code
validation_key	A string which is a validation keys that has been generated by *Motion* Perfect	

EXAMPLE:

Test that the user security code is valid before running the main program

```
    'Validate the user security code
    VALIDATE_ENCRYPTION_KEY(2,"1Wgltam0wzrbCVJwUgEnGU")
    RUN "MAIN_PROGRAM"
```

SEE ALSO:

`SET_ENCRYPTION_KEY, PROJECT_KEY`

VECTOR_BUFFERED

TYPE:

Axis Parameter (Read only)

DESCRIPTION:

This holds the total vector length of the buffered moves. It is effectively the amount the VPU can assume is available for deceleration. It should be executed with respect to the first axis in the group.

VALUE:

The vector length of buffered moves on the axis group.

EXAMPLE:
Return the total vector length for the current buffered moves whose axis group begins with axis(0).

```
>>BASE(0,1,2)
>>? VECTOR_BUFFERED AXIS(0)
1245.0000
>>
```

VERIFY

TYPE:
Reserved Keyword

VERSION

TYPE:
System Parameter (read only)

DESCRIPTION:
Returns the version number of the firmware installed on the *Motion Coordinator*.

You can use *Motion* Perfect to check the firmware version when looking at the controller configuration.

VALUE:
Controllers' firmware version number.

EXAMPLE:
Check the version of the firmware using the command line

```
>>? VERSION
2.0100
>>
```

VFF_GAIN

TYPE:
Axis Parameter

DESCRIPTION:

The velocity feed forward gain is a constant which is multiplied by the change in demand position. Velocity feed forward gain can be used to decreases the following error during constant speed by increasing the output proportionally with the speed. For a velocity feed forward Kvff and change in position ΔPd, the contribution to the output signal is:

Ovff = Kvff x ΔPd

VALUE:

Velocity feed forward constant (default =0)

EXAMPLE:

Set the **VFF_GAIN** on axis 15 to 12

```
    BASE(15)
    VFF_GAIN=12
```

VIEW

TYPE:

Reserved Keyword

VOLUME_LIMIT

TYPE:

Axis Function

SYNTAX:

VOLUME_LIMIT(mode, [,table_offset])

DESCRIPTION:

VOLUME_LIMIT enables a software limit that restricts the motion into a defined three dimensional shape. The calculations are performed on **DPOS** and so it can be used in addition to a **FRAME**. The limit applies to axes defined in a **FRAME_GROUP**.

VOLUME_LIMIT requires the kinematic runtime **FEC**

If no **FRAME_GROUP** is defined then a ‘parameter out of range’ run time error will be returned when **VOLUME_LIMIT** is called.

All axes in the **FRAME_GROUP** must have the same **UNITS**

When the limit is active moves on all axes in the **FRAME_GROUP** are cancelled and so will stop with the programmed **DECEL** or **FAST_DEC**. Any active **SYNC** is also stopped. **AXISSTATUS** bit 15 is also set. This means you should set your **VOLUME_LIMIT** smaller than the absolute operating limits of the robot.

PARAMETERS:

mode:	0	**VOLUME_LIMIT** is disabled
	1	Cylinder with cone base volume

MODE = 1 CYLINDER WITH CONE BASE VOLUME

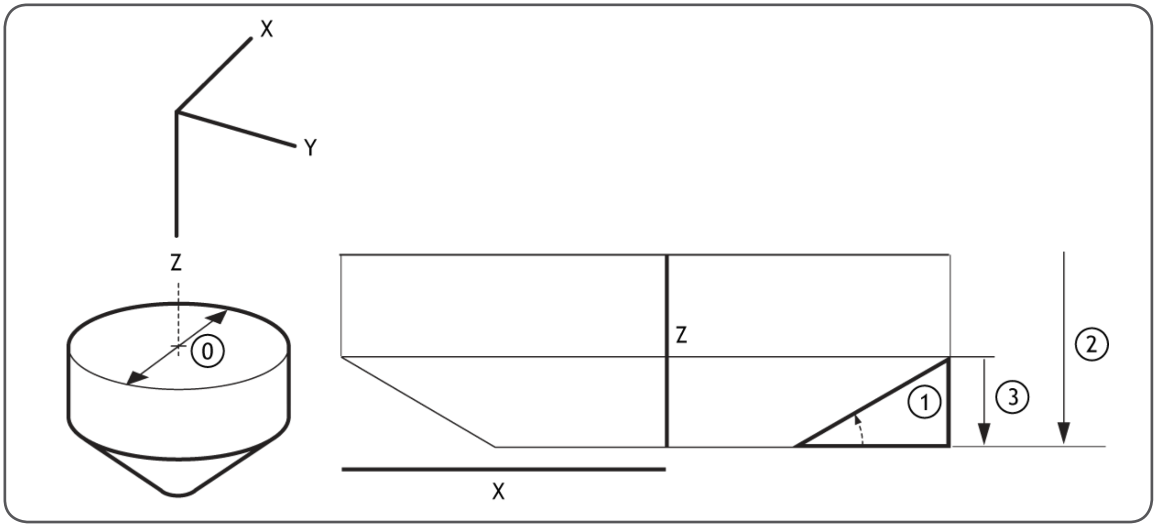
SYNTAX:

VOLUME_LIMIT(1, [,table_offset])

DESCRIPTION:

Mode 1 enables a cylinder with a cone base, this is a typical working volume for a delta robot.

The origin for the shape is the centre top . It is possible to align this with your coordinate system using the X,Y and Z offsets



If you wish to check which **USER_FRAME**, **TOOL_OFFSET** and **VOLUME_LIMIT** are active you can print the details using **FRAME_GROUP**(group).

PARAMETERS:

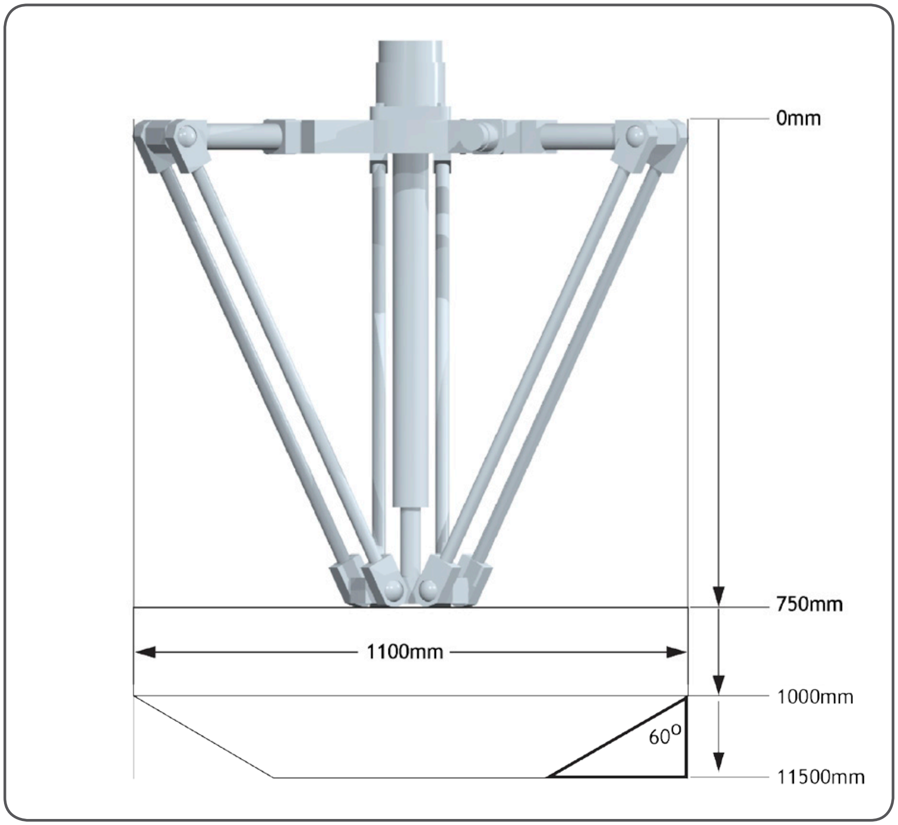
mode:	0	**VOLUME_LIMIT** is disabled
	1	Cylinder with cone base volume
table_offset:	The start position in the table to store the **VOLUME_LIMIT** configuration	

Mode 0 table values, all length values use **UNITS** from the first axis in the **FRAME_GROUP**.

0	Cylinder Diameter
1	Cone angle in radians
2	Total height
3	Cone height
4	X offset
5	Y offset
6	Z offset

EXAMPLE:

The cylinder with a flat base is typically used with delta robots (**FRAME**=14), the following example configures the **VOLUME_LIMIT** with this configuration.



```
TABLE(100,1100)' Cylinder diameter
TABLE(101,(60/360)* 2* PI)' Cone angle
TABLE(102,400)' Total height
TABLE(103,150)' Cone height
TABLE(104,0)' X offset
TABLE(105,0)' Y offset
TABLE(106,750)' Z offset

VOLUME_LIMIT(1,100)
```

VP_SPEED

TYPE:
Axis Parameter (Read Only)

ALTERNATE FORMAT:
`VPSPEED`

DESCRIPTION:
The velocity profile speed is an internal speed which is ramped up and down as the movement is velocity profiled.

VALUE:
The velocity profile speed in user `UNITS`/second.

EXAMPLE:
Wait until command speed is achieved:

```
    MOVE(100)
    WAIT UNTIL SPEED=VP_SPEED
```

VR

TYPE:
System Command

SYNTAX:
`value = VR(expression)`

DESCRIPTION:
Recall or assign to a global numbered variable. The variables hold real numbers and can be easily used as an array or as a number of arrays.

VR can also be used to hold `ASCII` representations of `STRINGS` and can be assigned with a string value. To read the string value back you must use `VRSTRING`.

The numbered variables are globally shared between programs and can be used for communication between programs. Be careful when multiple programs write to the same `VR`.

PARAMETERS:

value:	The value written to or read from the **VR**
expression:	Any valid TrioBASIC expression that produces an integer

EXAMPLES:

EXAMPLE 1:

Put value 1.2555 into **VR**() variable 15. Note local variable ‘val’ used to give name to global variable:

```
val=15
VR(val)=1.2555
```

EXAMPLE 2:

A transfer gantry has 10 put down positions in a row. Each position may at any time be **FULL** or **EMPTY**. **VR**(101) to **VR**(110) are used to hold an array of ten1’s or 0’s to signal that the positions are full (1) or **EMPTY** (0). The gantry puts the load down in the first free position. Part of the program to achieve this would be:

```
movep:
  MOVEABS(115) ‘MOVE TO FIRST PUT DOWN POSITION:
  FOR VR(0)=101 TO 110
    IF VR(VR(0))=0) THEN
      GOSUB load
    ENDIF
    MOVE(200)  ‘200 IS SPACING BETWEEN POSITIONS
  NEXT VR(0)
  PRINT “All Positions Are Full”
  WAIT UNTIL IN(3)=ON
  GOTO movep

load:
  ‘PUT LOAD IN POSITION AND MARK ARRAY
  OP(15,OFF)
  VR(VR(0))=1
```

EXAMPLE 3:

Assign **VR**(65) with the value **VR**(0) multiplied by Axis 1 measured position

```
VR(65)=VR(0)*MPOS AXIS(1)
PRINT VR(65)
```

EXAMPLE 4:

Write a string into a sequence of **VR**’s starting at index 10

```
VR(10)=”Hello World”
PRINT VR(10) ‘Prints 72, ASCII for H
PRINT VRSTRING(10) ‘Prints Hello World
```

VRSTRING

TYPE:
String Function

SYNTAX:
`VRSTRING(variable)`

DESCRIPTION:
Combines the contents of an array of **`VR`**() variables so that they can be printed as a text string or used as part of a **`STRING`** variable. All printable characters will be output and the string will terminate at the first null character found. (i.e. **`VR`**(n) contains 0)

PARAMETERS:

variable:	Number of first **`VR`**() in the character array.

EXAMPLES:

EXAMPLE1:
Print a sequence of characters stored in the **`VR`**'s starting at position 100.

```
    PRINT #5,VRSTRING(100)
```

EXAMPLE2:
Store the characters saved in the **`VR`**'s into one **`STRING`** variable.

```
    DIM string2 AS STRING(11)
    string2 = VRSTRING(0)
```

WA

TYPE:
Program Structure

SYNTAX:
WA(time)

DESCRIPTION:
Holds up program execution for the number of milliseconds specified in the parameter.

PARAMETERS:

time:	The number of milliseconds to wait for.

EXAMPLE:
Turn output 17 off 2 seconds after switching output 11 off.

```
    OP(11,OFF)
    WA(2000)
    OP(17,ON)
```

WAIT

TYPE:
Command

SYNTAX:
WAIT UNTIL expression

DESCRIPTION:
Suspends program execution until the expression is **TRUE**.

It is very common to use onlyWAIT **IDLE** and **WAIT LOADED** as the expression. In this situation the **UNTIL** is optional. When **IDLE** and **LOADED** are part of an expression **UNTIL** is required.

PARAMETERS:

condition:	Any valid TrioBASIC expression

EXAMPLES:

EXAMPLE 1:

The program waits until the measured position on axis 0 exceeds 150 then starts a movement on axis 7.

```
WAIT UNTIL MPOS AXIS(0)>150
MOVE(100) AXIS(7)
```

EXAMPLE 2:

Start a move and then suspend program execution until the move has finished. Note: This does not necessarily imply that the axis is stationary in a servo motor system.

```
MOVE(100)
WAIT IDLE
PRINT "Move Done"
```

EXAMPLE 3:

Switch output 45 ON at start of **MOVE**(350) and OFF at the end of that move.

```
MOVE(100)
MOVE(350)
WAIT UNTIL LOADED
OP(45,ON)
MOVE(200)
WAIT UNTIL LOADED
OP(45,OFF)
```

EXAMPLE 4:

Force the program to wait until either the current move has finished or an input goes ON.

As the expression contains **UNTIL** and **IN**(12) the **UNTIL** is required.

```
MOVELINK(distance, link_dist, acceldist, deceldist, linkaxis)
WAIT UNTIL IDLE OR IN(12)=ON
```

WDOG

TYPE:

System Parameter

DESCRIPTION:

Controls the **WDOG** relay contact used for enabling external drives. The **WDOG**=ON command **MUST** be issued in a program prior to executing moves. It may then be switched ON and OFF under program control. If however a following error condition exists on any axis the system software will override the **WDOG** setting and turn watchdog contact OFF. When **WDOG**=OFF, the relay is opened, the analogue outputs are set to 0V, the step/direction outputs and any digital axis enable functions are disabled.

EXAMPLE:

```
WDOG=ON
```

WDOG=ON / **WDOG=OFF** is issued automatically by *Motion* Perfect when the “Drives Enable” button is clicked on the control panel

When the **DISABLE_GROUP** function is in use, the watchdog relay and **WDOG** remain on if there is an axis error. In this case, the digital enable signal is removed from the drives in that group only.

WHILE .. WEND

TYPE:

Program Structure

SYNTAX:

```
WHILE condition
  Commands
WEND
```

DESCRIPTION:

The commands contained in the **WHILE..WEND** loop are continuously executed until the condition becomes **FALSE**. Execution then continues after the **WEND**. If the condition is false when the **WHILE** is first executed then the loop will be skipped.

PARAMETERS:

condition:	Any valid logical TrioBASIC expression
commands:	TrioBASIC statements that you wish to execute

EXAMPLE:

While input 12 is off, move the base axis and flash an LED on output 10

```
WHILE IN(12)=OFF
  MOVE(200)
  WAIT IDLE
  OP(10,OFF)
  MOVE(-200)
```

```
        WAIT IDLE
        OP(10,ON)
    WEND
```

WORLD_DPOS

TYPE:
Axis Parameter (Read Only)

DESCRIPTION:
The **WORLD_DPOS** is the demand position in the **FRAME** coordinate system. It sits between the **DPOS** and **AXIS_DPOS**.

With no **USER_FRAME** or **TOOL_OFFSET**, **WORLD_DPOS** is equal to **DPOS**. With no **FRAME**, **WORLD_DPOS** is equal to **AXIS_DPOS**. For some machinery configurations it can be useful to install a frame transformation which is not 1:1, these are typically machines such as robotic arms or machines with parasitic motions on the axes. In this situation when **FRAME** is not zero **WORLD_DPOS** returns the demand position for the programming point of the **FRAME**.

WORLD_DPOS can be scaled by **UNITS**

VALUE:
Demand position in user units of the **FRAME** programming point.

EXAMPLE:
Read the world demand position for axis 10 in user units

```
    >>PRINT WORLD_DPOS AXIS(10)
    5432
    >>
```

SEE ALSO:
AXIS_DPOS, DPOS, FRAME, TOOL_OFFSET, USER_FRAME

XOR

TYPE:
Logical and Bitwise operator

SYNTAX:
```
<expression1> XOR <expression2>
```

DESCRIPTION:

This performs and exclusive or function between corresponding bits of the integer part of two valid TrioBASIC expressions. It may therefore be used as either a bitwise or logical condition.

The XOR function between two values is defined as follows:

XOR	0	1
0	0	1
1	1	0

PARAMETERS:

expression1:	Any valid TrioBASIC expression
expression2:	Any valid TrioBASIC expression

EXAMPLE:

```
    a = 10 XOR (2.1*9)
```

TrioBASIC evaluates the parentheses first giving the value 18.9, but as was specified earlier, only the integer part of the number is used for the operation, therefore this expression is equivalent to: a=10 XOR 18. The XOR is a bitwise operator and so the binary action taking place is:

```
         01010
    XOR  10010
         11000
```

The result is therefore 24.

ZIP_READ

TYPE:

Command

SYNTAX:

```
ZIP_READ(function ,...)
```

DESCRIPTION:

This function will read a compressed file into RAM on the *Motion Coordinator* and then decompress it in blocks.

The file must be transferred to the SD card on the *Motion Coordinator* using the TextFileLoader (executable or ActiveX) with compression enabled and decompression disabled, that way the file will be stored in compressed format.

Internally we handle two buffer areas: compressed buffer and decompressed buffer. The compressed buffer is filled from the file, the decompressed buffer is filled from the compressed buffer. The data is transferred between the buffers when required.

PARAMETERS:

function:	description:
0	Initialise the **ZIP_READ** resources.
1	Release all the **ZIP_READ** resources.
2	Transfer a block of data from the decompressed buffer to **VR** or **TABLE** memory.
3	Skip a number of bytes in the decompressed buffer.
4	Read buffer indices.
5	Move to a position in the decompressed buffer.
6	Decompress the next buffer.

FUNCTION = 0:

SYNTAX:

value = **ZIP_READ**(0,”filename”[,decompress_block_size[,decompress_block_count]])

DESCRIPTION:

This function initialises the **ZIP_READ** resources.

Due to the size of the internal decompression data structures both the **TEXT_FILE_LOADER** and the **ZIP_READ** commands share the same data structure. This means that if the **TEXT_FILE_LOADER** is decompressing data then the **ZIP_READ** function will fail, and vice versa the **TEXT_FILE_LOADER** decompression will fail if the **ZIP_READ** function is running. This should not be a problem as the **TEXT_FILE_LOADER** must not decompress files that will be processed by the **ZIP_READ** command.

The file is decompressed in blocks. By default there is one 32 KB block. This decompress_block_size parameter allows the block size to be reduced. The block size will be rounded down to the nearest power of 2.

If decompress_block_count is greater than 1 then the **ZIP_READ** will perform double buffering. This means that one process may be decompressing the file whilst another process is using the decompressed data. The total amount of decompressed data is limited to 32 KB so the number of available decompression blocks is limited by the decompress_block_size

PARAMETERS:

value:	0	The initialisation failed
	1	The initialization succeeded but the complete compressed file could not be loaded into memory. This means that at some point another buffer will need to be read. This buffer read can take an appreciable time so a double buffering scheme might be required.
	2	The initialisation succeed and the complete compressed file was loaded into memory.
Filename:	Name of the file on the SD card to be opened.	
decompress_block_size:	2 – 32768 (default =32768)	
decompress_block_count:	1 - (32768 / decompress_block_size)	

EXAMPLE:

```
    IF ZIP_READ(0,”myfile.tfl”,2048)=0 THEN
        PRINT “Error initialising reader”
        STOP
    ENDIF
```

FUNCTION = 1:

SYNTAX:

`ZIP_READ(1)`

DESCRIPTION:

Frees all the resources held by the `ZIP_READ` command.

EXAMPLE:

```
    IF ZIP_READ(0,”myfile.tfl”,2048)=0 THEN
        PRINT “Error initialising reader”
        STOP
    ENDIF
    ZIP_READ(1)
```

FUNCTION = 2:

SYNTAX:

```
value=ZIP_READ(2,format,destination,start,length)
```

DESCRIPTION:

This function reads a block of data from the decompressed buffer into **VR** or **TABLE** memory. If there is not enough decompressed data available then more data will be decompressed.

PARAMETERS:

value:	Number of values stored	
format:	0	8 bit integer (**ASCII** character data)
	1	16 bit integer (little endian)
	2	16 bit integer (big endian)
	3	32 bit integer (little endian)
	4	32 bit integer (big endian)
	5	64 bit integer (little endian)
	6	64 bit integer (big endian)
	7	32 bit float (little endian)
	8	32 bit float (big endian)
	9	64 bit float (little endian)
	10	64 bit float (big endian)
destination:	0	Store data in **TABLE**
	1	Store data in **VR**
start:	0 ≤start	Position in the destination memory area at which to start storing the data.
length:	Number of values to store. The number of bytes processed will depend on the format, for example if format is 7 then a length of 100 will process 400 bytes	

If the return value this is less than the length parameter then we have reached the end of the file and any further reads will cause a TrioBASIC error.

EXAMPLE:

```
    IF ZIP_READ(0,"myfile.tfl",2048)=0 THEN
        PRINT "Error initialising reader"
        STOP
    ENDIF
    REPEAT
```

```
        c=ZIP_READ(2,0,0,1000,50)
    UNTIL c<50
    ZIP_READ(1)
```

FUNCTION = 3:

SYNTAX:
`value=ZIP_READ(3,length)`

DESCRIPTION:
This function skips a number of bytes in the decompressed buffer.

PARAMETERS:

value:	The number of bytes skipped
length:	The number of bytes to skip.

If the return value this is less than the length parameter then we have reached the end of the file and any further reads will cause a TrioBASIC error.

EXAMPLE:

```
    IF ZIP_READ(0,"myfile.tfl",2048)=0 THEN
        PRINT "Error initialising reader"
        STOP
    ENDIF
    ZIP_READ(3,23)
    REPEAT
        c=ZIP_READ(2,0,0,1000,50)
    UNTIL c<50
    ZIP_READ(1)
```

FUNCTION = 4:

SYNTAX:
`value=ZIP_READ(4,index)`

DESCRIPTION:
This function returns the value of the internal buffer indices.

PARAMETERS:

value:	The value of the specified index.	
index:	0	compressed buffer offset
	1	compressed buffer length
	2	compressed file offset
	3	uncompressed buffer offset
	4	uncompressed buffer length
	5	uncompressed file offset

EXAMPLE:

```
    IF ZIP_READ(0,”myfile.tfl”,2048)=0 THEN
        PRINT “Error initialising reader”
        STOP
    ENDIF
    ZIP_READ(3,23)
    REPEAT
        c=ZIP_READ(2,0,0,1000,50)
        PRINT “Compressed file indices: “;
        PRINT ZIP_READ(4,0),ZIP_READ(4,1),ZIP_READ(4,2)
        PRINT “Decompressed file indices: “;
        PRINT ZIP_READ(4,3),ZIP_READ(4,4),ZIP_READ(4,5)
    UNTIL c<50
    ZIP_READ(1)
```

FUNCTION = 5:

SYNTAX:

`value=ZIP_READ(5[,position])`

DESCRIPTION:

This function sets the absolute decompressed file position. If the optional position parameter is not specified then the default value of 0 is used.

PARAMETERS:

value:	The absolute position of the decompressed file or -1 if there is an error
position:	The absolute position in the decompressed file.

If the return value this is less than the length parameter then we have reached the end of the file and any further reads will cause a TrioBASIC error.

EXAMPLE:

```
    IF ZIP_READ(0,"myfile.tfl",2048)=0 THEN
        PRINT "Error initialising reader"
        STOP
    ENDIF
    ZIP_READ(3,23)
    VR(100)=-1
    REPEAT
        IF VR(100)>=0 THEN ZIP_READ(5,VR(100)):VR(100)=-1
        c=ZIP_READ(2,0,0,1000,50)
        PRINT "Compressed file indices: ";
        PRINT ZIP_READ(4,0),ZIP_READ(4,1),ZIP_READ(4,2)
        PRINT "Decompressed file indices: ";
        PRINT ZIP_READ(4,3),ZIP_READ(4,4),ZIP_READ(4,5)
    UNTIL c<50
    ZIP_READ(1)
```

FUNCTION = 6:

SYNTAX:

`value=ZIP_READ(6)`

DESCRIPTION:

This function decompresses the next buffer. This is only applicable when the decompress_buffer_count is greater than 1.

PARAMETERS:

value:	The absolute position of the decompressed file or -1 if there is an error.
position	The absolute position in the decompressed file.

If the return value this is less than the length parameter then we have reached the end of the file and

any further reads will cause a TrioBASIC error.

EXAMPLE:

```
    IF ZIP_READ(0,"myfile.tfl",2048,2)=0 THEN
        PRINT "Error initialising reader"
        STOP
```

```
ENDIF
ZIP_READ(3,23)
VR(100)=-1
REPEAT
    IF VR(100)>=0 THEN ZIP_READ(5,VR(100)):VR(100)=-1
    IF 2048-ZIP_READ(4,3)<50 THEN ZIP_READ(6)
    c=ZIP_READ(2,0,0,1000,50)
    PRINT "Compressed file indices: ";
    PRINT ZIP_READ(4,0),ZIP_READ(4,1),ZIP_READ(4,2)
    PRINT "Decompressed file indices: ";
    PRINT ZIP_READ(4,3),ZIP_READ(4,4),ZIP_READ(4,5)
UNTIL c<50
ZIP_READ(1)
```